REFERENCES

1. Kleiner, L.W., Karasz, F.E. and MacKnight, W.J. Compatible Glassy Polyblend Based Upon Poly(2,6-Dimethyl-1,4-Phenylene Oxide):Tensile Modulus Studies. Polymer Engineering and Science 19 (1979): 519-524.
2. Nielsen, L. E. Predicting the properties of mixtures: Mixture rule in science and engineering. New York: Marcel Deckker, 1978.
3. Manson, J. A. and Sperling, L. H. Polymer blends and composites. New York: Plenum Press, 1976, quote in Sperling, L. H., Chiu. T. W., Gramlich, R. G., and Thomas, D. A. J. Paint Technology 46 (1974): 47.
4. Kleiner, L. W. The tensile properties of compatible glassy polyblends based upon poly(2,6-dimethyl-1,4-phenylene oxide). Ph.D. dissertation, University of Massachusetts, 1978.
5. Kerner, E. H. The elastic and thermo-elastic properties of composite media: Proc. Phys. Soc., B69 (1956):808-813.
6. Kleiner, L.W. The tensile properties of compatible glassy polyblends based upon poly(2,6-dimethyl-1,4-phenylene oxide). Ph.D. dissertation, University of Massachusetts, 1978, quote in Hashin, Z. and Shtrikman, S. J. Mech. Phys. Solids (1963):11,127.
7. Nielsen, L. E. Mechanical properties of polymer and composites. New York: Marcel Deckker, 1974.
8. Kleiner, L.W. The tensile properties of compatible glassy polyblends based upon poly(2,6-dimethyl-1,4-phenylene oxide). Ph.D. dissertation, University of Massachusetts, 1978, quote in Halpin, J.C. J. Composite Mater. , 3(1969): 732.
9. Nielsen, E. L. J. Appl. Phys., 41 (1970): 4626-4627.
10. Nielsen, E. L. Rheol. Acta., 13 (1974): 86-92.

11. Kleiner, L. W. The tensile properties of compatible glassy polyblends based upon poly(2,6-dimethyl-1,4-phenylene oxide). Ph.D. dissertation, University of Massachusetts, 1978, quote in Miyamoto, T., Kodama, K. and Shibayama, K. J. Polym. Sci. A2 8 (1970): 2095.

12. Kleiner, L. W. The tensile properties of compatible glassy polyblends based upon poly(2,6-dimethyl-1,4-phenylene oxide). Ph.D. dissertation, University of Massachusetts, 1978, quote in Hashin, Z. Appl. Mech. Rev. 17 (1964): 1.

13. Kleiner, L. W. The tensile properties of compatible glassy polyblends based upon poly(2,6-dimethyl-1,4-phenylene oxide). Ph.D. dissertation, University of Massachusetts, 1978, quote in Nielson, L. E., Wall, A. R. and Richmond G. P. SPE J. 11 (1955): 22.

14. Kleiner, L. E. The tensile properties of compatible glassy polyblends based upon poly(2,6-dimethyl-1,4-phenylene oxide). Ph.D. dissertation, University of Massachusetts, 1978, quote in Seymour, B. R. Polym.-Plast. Technol. Eng. 7(1) (1976): 49.

15. Kleiner, L. W. The tensile properties of compatible glassy polyblends based upon poly(2,6-dimethyl-1,4-phenylene oxide). Ph.D. dissertation, University of Massachusetts, 1978, quote in Nielsen, L. E. J. Appl. Polym. Sci. 19 (1975): 1485.

16. Kleiner, L. W. The tensile properties of compatible glassy polyblends based upon poly(2,6-dimethyl-1,4-phenylene oxide). Ph.D. dissertation, University of Massachusetts, 1978, quote in Davies, A. E. W. J. Phys. D4 (1971): 1176, 1325.

17. Manson, J. A. and Sperling, L. H. Polymer blends and composites. New York: Plenum Press, 1976.

18. Kleiner, L. W. The tensile properties of compatible glassy polyblends based upon poly(2,6-dimethyl-1,4-phenylene oxide). Ph.D. dissertation, University of Massachusetts, 1978, quote in Bondi, A. Physical properties of Molecular crystals, Liquids, and Glasses. New York: John Wiley & Sons, 1968.

19. Flaris, V. and Stachurski, H. Z. The Mechanical Behavior of Blends of Polyethylene ,Polypropylene, and an Ethylene-Propylene Block Copolymer at -20^{0}C. Journal of Applied Polymer Science 45 (1992):1789-1798, quote in Nielsen, L. E. J. Appl. Polym. Sci. 10 (1966): 97.

20. Flaris, V. and Stachurski, H. Z. The Mechanical Behavior of Blends of Polyethylene ,Polypropylene, and an Ethylene-Propylene Block Copolymer at -20^{0}C. Journal of Applied Polymer Science 45 (1992):1789-1798, quote in Leidner, J. and Woodhams, T. R. Journal of Applied Polymer Science 18 (1974):1639.

21. Flaris, V. and Stachurski, H. Z. The Mechanical Behavior of Blends of Polyethylene ,Polypropylene, and an Ethylene-Propylene Block Copolymer at -20^{0}C. Journal of Applied Polymer Science 45 (1992):1789-1798, quote in Nicolais, L. and Narkis, M. Polym. Eng. Sci. 11 (1971): 194.

22. Flaris, V. and Stachurski, H. Z. The Mechanical Behavior of Blends of Polyethylene ,Polypropylene, and an Ethylene-Propylene Block Copolymer at -20^{0}C. Journal of Applied Polymer Science 45 (1992):1789-1798, quote in Nielsen, L. E. J. Composite Mater. , 1 (1967): 100.

23. Flaris, V. and Stachurski, H. Z. The Mechanical Behavior of Blends of Polyethylene ,Polypropylene, and an Ethylene-Propylene Block Copolymer at -20^{0}C. Journal of Applied Polymer Science 45 (1992):1789-1798, quote in Kunori, T. and Geil, H. P. J. Macromo. Sci. Phys. B18 (1980): 135.

24. Kleiner, L. W. The tensile properties of compatible glassy polyblends based upon poly(2,6-dimethyl-1,4-phenylene oxide). Ph.D. dissertation, University of Massachusetts, 1978, quote in Nielsen, L. E. J. Appl. Polym. Sci. 10 (1966): 97.

25. Scheff' H. J. Roy. Stat. Soc., London B20 (1958): 344.

26. Mondragon, I. and Nazabal, J. Tensile Properties of Polyacrylate-Polycarbonate Blends. Polymer Engineering and Science 25 (1985): 178-181.

27. Ueda, H., Karasz, F. E. and Fariss, R. J. Characterization of Linear Polyethylene of Ultrahigh and Moderate Molecular Weights. Polymer Engineering and Science 26 (1986): 1483-1488.

28. Ahn, T.O., Kim, C.K., Kim, B.K., Jeong, H.M. and Huh, J.D. Binary Blends of Nylons With Ethylene Vinyl alcohol Copolymer: Morphological, Thermal, Rheological, and Mechanical behavior. Polymer Engineering and Science 30 (1990): 341-349.

29. Lee, Y. K., Jeong, Y. T., Kim, K. C., Jeong, H. M. and Kim, B. K. Ultralow Density Polyethylene Blends With Polypropylene. Polymer Engineering and Science 31 (1991): 944-953.

30. Stachurski, Z. H. and Flaris, V. The Mechanical Behavior of Blends of Polyethylene ,Polypropylene, and an Ethylene-Propylene Block Copolymer at -20^{0}C. Journal of Applied Polymer Science 45 (1992):1789-1798.

31. Pal, S. N., Ramani, A. V. and Subramanian, N. Polymer Engineering and Science 32 (1992): 845-853.

32. Billmayer, F. W. Textbook of polymer science. 3 rd ed. Singapore: John Wiley & Sons,1984.

33. Brandup, J. and Immergut, E. H. Polymer Handbook. Canada: John Wiley and Sons, 1975.

34. Paveena Khansawai. 1992. Effect of Poly(Phenyl Vinyl Ketone) on Photodegradation of High Density Polyethylene Film. Master's Thesis, Chulalongkorn University.

35. Faullimmel, J. Polymer Synthesis and Polymer Characterization Laboratory Dept. Material Science, Faculty of Science, Chulalongkorn University, 1986.

36. Ahn, O. T., Lee, S., Jeong, M. H. and Lee, W. S. Compatibilizing effect of polyacrylate-polyamide-6 block copolymer on polyacrylate/polyamide-6 blend:2 Polymer 37 (1996): 3559-3565.

37. Kim, K. B. and Choi, H. C. Melt blends of poly(methyl methacrylate) with phenoxy. Polymer 37 (1996): 807-812.

38. Cha, J. Y., Choe, S., Lee, S. H., Choi, J. H. and Yoon, S. J. Miscibility of poly(3-hydroxybutylate-co-3-hydroxyvalelate) and poly(vinyl chloride) blends. Polymer 36 (1995):4977-4982.

39. Montiel, G. A., Keskkula, H. and Paul, D. R. Impact-modified nylon 6/polypropylene blends: 1. Morphology-property relationships. Polymer 36 (1995):4587-4603.

40. George, S., Joseph, R., Thomas, S. and Varughese, K. T. Blend of isotactic polypropylene and nitrile rubber: morphology, mechanical properties and compatibilization. Polymer 36 (1995):4405-4416.

41. Hayashi, H., Kakimoto, M. and Imai, Y. Polymerization blending for compatible poly(ether sulphone)/aramide blends based on polycondensation of N-silylated m-phenylenediamine with isophataloyl chloride in poly(ether sulfone) solution. Polymer 36 (1995):2797-2805.

42. Akhtar, S. and White, L. J. Characteristics of Binary and Ternary Blends of Poly(P-Phenylene Sulfide) With Poly(Bis Phenol A) Sulfone and Poletherimide. Polymer Engineering and Science 31 (1991): 84-91.

43. Baird, G. D. and Datta, A. Compatibilization of thermoplastic composites based on blends of polypropylene with two liquid crystalline polymers. Polymer 36 (1995): 505-514.

44. Nazabal, J., Gaztelumendi, M. and Julado, J. M. Influence of Migration of Plasticizer during Melt Mixing on the Transitions and Properties of PC/CAB Blends. Journal of Polymer science: Part B: Polymer Physics. 28 (1990): 1051-1031.

45. Yamaoka, Ikuro. Toughened polymer blends composed of a ductile styrene-butadiene-styrene matrix with brittle methyl methacrylate-styrene particles. Polymer 36 (1995): 3359-3368.

46. Hay, N. J. and Zhou, Q. X. Structure-property relationships in annealed blends of linear low density polyethylene with isotactic polypropylene. Polymer 34 (1993): 4710-4716.

47. Ohsako, T., Nagura, K. and Nozue, I. Morphologies and tensile properties of elastomer-modified epoxy and polycarbonate blended systems. Polymer 34 (1993): 5080-5084.

48. Martinez, M. J., Eguiazabal, I. J. and Nazabal, J. Miscibility Level and Properties of Poly(Ether Imide)/Poly(Ethylene Terephthalate) Blends. Journal of Applied Polymer Science 62 (1996): 385-391.

49. Garcia-Rejon, A. and Alvarez, C. Mechanical and Flow Properties of High-Density Polyethylene/Low-Density Polyethylene. Polymer Engineering and Science 27 (1987): 640-646.

50. Schafer, U. F. and Hourston, J. D. Poly(ether urethane)/poly(ethyl methacrylate) Interpenetrating polymer networks: morphology, phase continuity and mechanical properties as a function of composition. Polymer 37 (1996): 3521-3530.

51. Bains, M., Balke, T. S., Reck, D. and Horn, J. The compatibility of linear low density Polyethylene-Polypropylene Blends: Viscosity Ratio Plots Polymer Engineering and Science 34 (1994): 1260-1268.

52. Ajji, A. Orientation and Mechanical Properties of Polycarbonate-Linear low Density Polyethylene Blends. Polymer Engineering and Science 29 (1989): 1544-1550.

53. Hwung, D. S. and Chiang, W. Y. Properties of Polycarbonate/Acrylonitrile-Butadiene-Styrene Blends. Polymer Engineering and Science 27 (1987): 632-639.

54. Allen, B. R. and Avvakian W. R. Properties of a Transparent Polycarbonate Copolyester Blend. Polymer Engineering and Science 25 (1985): 462-466.

55. Miettinen, H. R., Seppala, J. and Ikkala, T. O. Effect of Compatibilizer on the properties of Polyamide/Polypropylene Blends. Polymer Engineering and Science 32 (1992):868-877.

56. Miyasaka, K., Inoue, T. and Koo, K. K. Toughened Plastics Consisting of Brittle Particles and Ductile Matrix. Polymer Engineering and Science 25 (1985): 741-746.

57. Spruiell, E. J., Kotanis, A. M. and Department of Material Science and Engineering, University of Tennessee. Biaxially Oriented Films Prepared From Poly(vinyl Choride)/Poly(methyl Methacrylate Co Imide) Blends. Polymer Engineering and Science 29 (1989): 1528-1533.

58. Yin, J., Yin, Z. and Zhang, X. The Phase Inversion and Morphology of nylon1010/ Polypropylene Blends. Journal of Applied Polymer Science 62 (1996): 893-901.

59. Soares, G. B., Gomes, S. A. and Jansen, P. The use of EVA-containing Mercapto Group in Natural Rubber-EVA Blends. II. The effect of Curing System on Mechanical and Thermal Properties of the Blends. Journal of Applied Polymer Science 61 (1996): 591-598.

60. Utracki, A. L., Carreau, J. P. and Dumoulin, M. N. Rheological Properties of Linear Low Density Polyethylene/Polypropylene Blends Part 2: Solid State Behavior. Polymer Engineering and Science 27 (1987): 1627-1633.

61. Nazabal, J., Eguiazabal, I. J. and Bastida, S. Phase behavior, Morphology and properties of poly(ether imide)/polyacrylate blends. Polymer 37 (1996): 2317-2322.

62. De, K. S., De, P.P. and Datta, S. Blend of Ionomers. Journal of Applied Polymer Science 61 (1996): 1839-1846.

63. Kolarik, J. A model for the yield strength of binary blends of thermoplastics. Polymer 35 (1994): 3631-3637.

64. Teyssie, P. H. And FaYt, R. Molecular Design of multicomponent Polymer Systems. XV Morphology and mechanical properties of low Density Polyethylene With Acrylonitril-Butadiene-Styrene(ABS), Emulsified by a Poly(Hydrogenated Butadiene-b-Methyl Methacrylate) Copolymer. Polymer Engineering and Science 29 (1989): 538-542.

65. Lindsey, R. C., Paul, D. R. and Barow, W. J. Mechanical Properties of HDPE-PS-SEBS Blends. Journal of Applied Polymer Science 26 (1981): 1-8.

66. Suarez, H., Barow, W. J. and Paul, D. R. Mechanical properties of ABS/Polycarbonate Blends. Journal of Applied Polymer Science 29 (1984): 3253-3259.

67. Lindsey, R. C., Barow, W. J. and Paul, D. R. Blends from Reprocessed Coextruded Products. Journal of Applied Polymer Science 26 (1981): 9-16.

68. Keitz, D. J., Barow, W. J. and Paul, D. R. Polycarbonate Blends with Styrene/ Acrylonitrile Copolymer. Journal of Applied Polymer Science 29 (1984): 3131-3145.

69. Murff, R. S., Barow, W. J. and Paul, D. R. Thermal and Mechanical Behavior of Polycarbonate-Poly(ethylene Terephthalate) Blends. Journal of Applied Polymer Science 29 (1984): 3231-3240.

70. Bartlett. W. D., Barow, W. J. and Paul, D. R. Mechanical Properties of Blends Containing HDPE and PP. Journal of Applied Polymer Science 29 (1984): 2351-2360.

71. Lovinger, J. A. and Williams, M. L. Tensile Properties and Morphology of blends of Polyethylene and Polypropylene. Journal of Applied Polymer Science 29 (1980): 1703-1713.

72. Qipeng, G., Jinyu, H., Tianlu, C. and Zhiliu, F. Mechanical Properties of Miscible Phenolphthalein Poly(Ether Ether Ketone)/Polysulfone blends. Polymer Engineering and Science 30 (1990): 44-48.

73. Colovoy, A., Cheung, M. F. and Oene, H. V. The phase Behavior and Mechanical Properties of Polyacrylate and Polycarbonate Blends. Polymer Engineering and Science 27 (1987): 1642-1648.

74. Eguiazabal, I. J., Fernandez-Berridi, J. M., Iruin, J. J. and Maiza, I. PBT/PAr Mixtures: Influence of Interchange Reaction on mechanical Properties. Journal of Applied Polymer Science 59 (1996): 329-337.

75. Arazak, A., Eguiazabal, I. J. and Nazabal, J. Compatibility in Immiscible Poly(ether ether ketone)/Poly(ether sulfone) Blends. Journal of Applied Polymer Science 58 (1995): 653-661.

76. Sathe, N. S., Devi, S., Srinivasa Rao, S. G. and Rao, V. K. Relationship Between Morphology and Mechanical properties of Binary and Compatibilized Ternary Blend Polypropylene and Nylon 6. Journal of Applied Polymer Science 61 (1995): 97-107.

APPENDIX

APPENDIX A

ASTM D 638M

Designation: D 638M – 91a
METRIC

An American National Standard

Standard Test Method for Tensile Properties of Plastics (Metric)[1]

This standard is issued under the fixed designation D 638M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of the tensile properties of unreinforced and reinforced plastics in the form of standard dumbbell-shaped test specimens when tested under defined conditions of pretreatment, temperature, humidity, and testing machine speed.

1.2 This test method can be used for testing materials of any thickness up to 10 mm. However, for testing specimens in the form of thin sheeting, including film less than 1.0 mm, Test Methods D 882 is the preferred test method. Materials with a thickness greater than 10 mm must be reduced by machining.

NOTE 1—This test method is the companion to inch-pound Test Method D 638.

NOTE 2—This test method may be used for testing phenolic resin molded or laminated materials. However, where these materials are used as electrical insulation, such materials should be tested in accordance with Methods D 229 and Test Method D 651.

NOTE 3—This test method is not intended to cover precise physical procedures. It is recognized that the constant-rate-of-crosshead-movement type of test leaves much to be desired from a theoretical standpoint, that wide differences may exist between rate of crosshead movement and rate of strain between gage marks on the specimen, and that the testing speeds specified disguise important effects characteristic of materials in the plastic state. Further, it is realized that variations in the thicknesses of test specimens, which are permitted by these procedures, produce variations in the surface-volume ratios of such specimens, and that these variations may influence the test results. Hence, where directly comparable results are desired, all samples should be of equal thickness. Special additional tests should be used where more precise physical data are needed.

NOTE 4—For tensile properties of resin-matrix composites reinforced with oriented continuous or discontinuous high modulus >20 GPa fibers, tests shall be made in accordance with Test Method D 3039.

1.3 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 229 Methods of Testing Rigid Sheet and Plate Materials Used for Electrical Insulation[2]

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[3]

D 638 Test Method for Tensile Properties of Plastics[3]

D 651 Test Method for Tensile Strength of Molded Electrical Insulating Materials[2]

D 882 Test Methods for Tensile Properties of Thin Plastic Sheeting[3]

D 883 Terminology Relating to Plastics[3]

D 3039 Test Method for Tensile Properties of Fiber-Resin Composites[4]

D 4000 Classification System for Specifying Plastic Materials[5]

D 4066 Specification for Nylon Injection and Extrusion Materials[5]

E 4 Practices for Load Verification of Testing Machines[6]

E 83 Practice for Verification and Classification of Extensometers[6]

3. Terminology

3.1 *Definitions*—Definitions of terms applying to this test method appear in Terminology D 883 and Annex A1.

4. Significance and Use

4.1 This test method is designed to produce tensile property data for the control and specification of plastic materials. These data are also useful for qualitative characterization purposes and for research and development. For many materials, there may be a specification that requires the use of this test method, but with some procedural modifications that take precedence when adhering to the specification. Therefore, it is advisable to refer to that material specification before using this test method. Table 1 in Classification D 4000 lists the ASTM materials standards that currently exist.

4.2 Tensile properties may vary with specimen preparation and with speed and environment of testing. Consequently, where precise comparative results are desired, these factors must be carefully controlled.

4.2.1 It is realized that a material cannot be tested without also testing the method of preparation of that material. Hence, when comparative tests of materials per se are desired, the greatest care must be exercised to ensure that all samples are prepared in exactly the same way, unless the test is to include the effects of sample preparation. Similarly, for referee or comparisons within any given series of specimens, care must be taken to secure the maximum degree of uniformity in details of preparation, treatment, and handling.

4.3 Tensile properties may provide useful data for plastics

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[1] This test method is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.10 on Mechanical Properties.

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[2] *Annual Book of ASTM Standards*, Vol 10.01.

[3] *Annual Book of ASTM Standards*, Vol 08.01.

[4] *Annual Book of ASTM Standards*, Vol 15.03.

[5] *Annual Book of ASTM Standards*, Vol 08.03.

[6] *Annual Book of ASTM Standards*, Vol 03.01.

engineering design purposes. However, because of the high degree of sensitivity exhibited by many plastics to rate of straining and environmental conditions, data obtained by this test method cannot be considered valid for applications involving load-time scales or environments widely different from those of this test method. In cases of such dissimilarity, no reliable estimation of the limit of usefulness can be made for most plastics. This sensitivity to rate of straining and environment necessitates testing over a broad load-time scale (including impact and creep) and range of environmental conditions if tensile properties are to suffice for engineering design purposes.

NOTE 5—Since the existence of a true elastic limit in plastics (as in many other organic materials and in many metals) is debatable, the propriety of applying the term "elastic modulus" in its quoted, generally accepted definition to describing the stiffness or rigidity of a plastic has been seriously questioned. The exact stress-strain characteristics of plastic materials are highly dependent on such factors as rate of application of stress, temperature, previous history of specimen, etc. However, stress-strain curves for plastics, determined as described in this test method, almost always show a linear region at low stresses, and a straight line drawn tangent to this portion of the curve permits calculation of an elastic modulus of the usually defined type. Such a constant is useful if its arbitrary nature and dependence on time, temperature, and similar factors are realized.

5. Apparatus

5.1 *Testing Machine*—A testing machine of the constant-rate-of-crosshead movement type and comprising essentially the following:

5.1.1 *Fixed Member*—A fixed or essentially stationary member carrying one grip.

5.1.2 *Movable Member*—A movable member carrying a second grip.

5.1.3 *Grips*—Grips for holding the test specimen between the fixed member and the movable member. The grips shall be self-aligning, that is, they shall be attached to the fixed and movable member, respectively, in such a manner that they will move freely into alignment as soon as any load is applied, so that the long axis of the test specimen will coincide with the direction of the applied pull through the center line of the grip assembly. The specimens should be aligned as perfectly as possible with the direction of pull so that no rotary motion that may induce slippage will occur in the grips; there is a limit to the amount of misalignment self-aligning grips will accommodate.

5.1.3.1 The test specimen shall be held in such a way that slippage relative to the grips is prevented insofar as possible. Grip surfaces that are deeply scored or serrated, with a pattern similar to those of a coarse single-cut file, serrations about 2.5 mm apart and about 1.5 mm deep, have been found satisfactory for most thermoplastics. Finer serrations have been found to be more satisfactory for harder plastics such as the thermosetting materials. The serrations should be kept clean and sharp. Breaking in the grips may occur at times, even when deep serrations or abraded specimen surfaces are used; other techniques must be used in these cases. Other techniques that have been found useful, particularly with smooth-faced grips, are abrading that portion of the surface of the specimen that will be in the grips, and interposing thin pieces of abrasive cloth, abrasive paper, or plastic or rubber-coated fabric, commonly called hospital sheeting, between the specimen and the grip surface. Number 80 double-sided abrasive paper has been found effective in many cases. An open-mesh fabric, in which the threads are coated with abrasive, has also been effective. Reducing the cross-sectional area of the specimen may also be effective. The use of special types of grips is sometimes necessary to eliminate slippage and breakage in the grips.

5.1.4 *Drive Mechanism*—A drive mechanism for imparting to the movable member a uniform, controlled velocity with respect to the stationary member, with this velocity to be regulated as specified in Section 9.

5.1.5 *Load Indicator*—A suitable load-indicating mechanism capable of showing the total tensile load carried by the test specimen when held by the grips. This mechanism shall be essentially free from inertia-lag at the specified rate of testing and shall indicate the load with an accuracy of ±1 % of the indicated value, or better. The accuracy of the testing machine shall be verified in accordance with Practices E 4.

NOTE 6—Experience has shown that many testing machines now in use are incapable of maintaining accuracy for as long as the periods between inspection recommended in Practices E 4. Hence, it is recommended that each machine be studied individually and verified as often as may be found necessary. It will frequently be necessary to perform this function daily.

5.1.6 The fixed member, movable member, drive mechanism, and grips shall be constructed of such materials and in such proportions that the total elastic longitudinal strain of the system constituted by these parts does not exceed 1 % of the total longitudinal strain between the two gage marks on the test specimen at any time during the test and at any load up to the rated capacity of the machine.

5.2 *Extension Indicator* (extensometer)—A suitable instrument shall be used for determining the distance between two designated points within the gage length of the test specimen as the specimen is stretched. For referee purposes, the extensometer must be set at the full gage length of the specimen, as shown in Fig. 1. It is desirable, but not essential, that this instrument automatically record this distance, or any change in it, as a function of the load on the test specimen, or of the elapsed time from the start of the test, or both. If only the latter is obtained, load-time data must also be taken. This instrument shall be essentially free of inertia at the specified speed of testing. Extensometers shall be classified and their calibration periodically verified in accordance with Practice E 83.

5.2.1 *Modulus-of-Elasticity Measurements*—For modulus-of-elasticity measurements, an extensometer with a maximum strain error of 0.0002 mm/mm that automatically and continuously records shall be used. A Class B-2 extensometer (Practice E 83) meets this requirement.

5.2.2 *Low-Extension Measurements*—For elongation-at-yield and low-extension measurements (nominally 20 % or less), the same above extensometer, attenuated to 20 % extension, may be used. In any case, the extensometer system must meet at least Class C (Practice E 83) requirements, which include a fixed strain error of 0.001 strain or ±1.0 % of the indicated strain, whichever is greater.

5.2.3 *High-Extension Measurements*—For making measurements at elongations greater than 20 %, measuring techniques with error no greater than ±10 % of the measured value are acceptable.

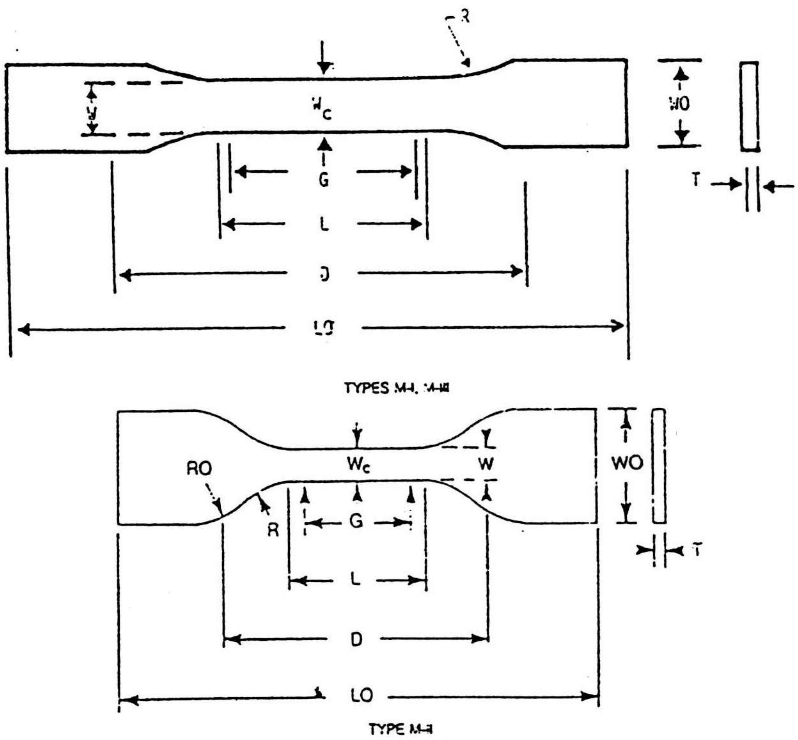


FIG. 1 Tension Test Specimens

5.3 *Micrometers*—Suitable micrometers, reading to at least 0.02 mm for measuring the width and thickness of the test specimens. The thickness of nonrigid plastics should be measured with a dial micrometer that exerts a pressure of 25 ± 5 kPa on the specimen and measures the thickness to within 0.02 mm. The anvil of the micrometer shall be at least 30 mm in diameter and parallel to the face of the contact foot.

6. Test Specimens

6.1 *Sheet, Plate, and Molded Plastics:*

6.1.1 *Rigid and Semirigid Plastics*—The test specimens shall conform to the dimensions shown in Fig. 1. The Type M-I specimen is the preferred specimen and shall be used where sufficient material having a thickness of 10 mm or less is available. The Type M-III specimen shall be used where only limited material having a thickness of 4 mm or less is available for evaluation, or where a large number of specimens are to be exposed in a limited space (thermal and environmental stability tests, etc.). The Type M-II specimen should be used when direct comparisons are required between materials in different rigidity cases (that is, nonrigid and semirigid).

6.1.2 *Nonrigid Plastics*—The test specimen shall conform to the dimensions shown in Fig. 1. The Type M-II specimen shall be used for testing nonrigid plastics with a thickness of 4 mm or less. The Type M-I specimen must be used for all materials with a thickness greater than 4 mm but not more than 10 mm.

6.1.3 *Reinforced Composites*—The test specimen for reinforced composites, including highly orthotropic laminates, shall conform to the dimensions of the Type M-I specimen shown in Fig. 1.

6.1.4 *Preparation*—Test specimens shall be prepared by machining operations, or die cutting, from materials in sheet, plate, slab, or similar form. Materials thicker than 10 mm must be machined to 10 mm for use as Type M-I specimens. Specimens can also be prepared by molding the material to be tested.

NOTE 7—Test results have shown that for some materials such as glass cloth, SMC, and BMC laminates, other specimen types should be considered to ensure breakage within the gage length of the specimen, as mandated by Section 8.3.

NOTE 8—When preparing specimens from certain composite laminates such as woven roving, or glass cloth, care must be exercised in cutting the specimens parallel to the reinforcement. The reinforcement will be sufficiently weakened by cutting on a bias, resulting in lower laminate properties, unless testing of specimens in a direction other than parallel with the reinforcement constitutes a variable being studied.

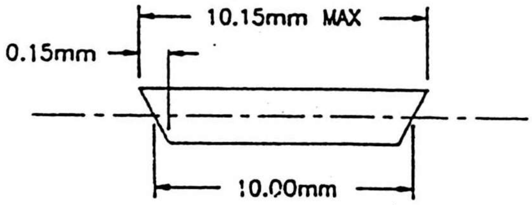
NOTE 9—Specimens prepared by injection molding may have different tensile properties than specimens prepared by machining or die-cutting because of the orientation induced. This effect may be more pronounced in specimens with narrow sections.

6.2 All surfaces of the specimen shall be free of visible flaws, scratches, or imperfections. Marks left by coarse machining operations shall be carefully removed with a fine file or abrasive and the filed surfaces shall then be smoothed with abrasive paper (No. 00 or finer). The finishing sanding strokes shall be made in a direction parallel to the long axis

Dimensions (see drawings)	Specimen Dimensions for Thickness, T, mm[D]: 10 or Under	4 or Under		Tolerances
	Type M-I	Type M-II	Type M-III	
W—Width of narrow section[A,B]	10	6	2.5	±0.5[H]
L—Length of narrow section	60	33	10	±0.5
WO—Width of overall, min[E,F]	20	25	10	±0.5
LO—Length overall, min[E,G]	150	115	60	no max
G—Gage length[C]	50	—	7.5	±0.25
G—Gage length[C]	—	25	—	±0.5
D—Distance between grips	115	80	25	±5
R—Radius of fillet	60	14	15	±1
RO—Outer radius (Type II)	—	25	—	±1

[A] The width at the center W_c shall be plus 0.00 mm, minus 0.10 mm compared with width W at other parts of the reduced section. Any reduction in W at the center shall be gradual, equally on each side so that no abrupt changes in dimension result.

[B] For molded specimens, a draft of not over 0.15 mm may be allowed for Type M-1, 4 mm in thickness, and this should be taken into account when calculating width of the specimen. Thus a typical section of a molded Type M-I specimen, having the maximum allowable draft, could be as follows:



[C] Test marks or initial extensometer span.

[D] Thickness, T, shall be 4 ± 0.2 mm for all types of molded specimens where possible. If specimens are machined from sheets or plates, thickness, T, may be the thickness of the sheet or plate provided this does not exceed the range stated for the intended specimen type. For sheets of nominal thickness greater than 10 mm, the specimens shall be machined to 10 ± 0.2 mm in thickness, for use with the Type M-I specimen. For sheets of nominal thickness between 10 and 50 mm approximately equal amounts shall be machined from each surface. For thicker sheets both surfaces of the specimen shall be machined and the location of the specimen with reference to the original thickness of the sheet, shall be noted. Tolerances on thickness less than 10 mm shall be those standard for the grade of material tested.

[E] A Type M-I specimen, having an overall width of 20 mm and an overall length of 215 mm is the preferred specimen and shall be used whenever possible.

[F] Overall widths greater than the minimum indicated may be desirable for some materials in order to avoid breaking in the grips.

[G] Overall lengths greater than the minimum indicated may be desirable either to avoid breaking in the grips or to satisfy special test requirements.

[H] The Type M-II specimen is intended for nonrigid plastics but may be used for rigid types where desirable.

FIG. 1 *Continued*

of the test specimen. All flash shall be removed from a molded specimen, taking great care not to disturb the molded surfaces. In machining a specimen, undercuts that would exceed the dimensional tolerances shown in Fig. 1 shall be scrupulously avoided. Care shall also be taken to avoid other common machining errors.

6.3 If it is necessary to place gage marks on the specimen, this shall be done with a wax crayon or India ink that will not affect the material being tested. Gage marks shall not be scratched, punched, or impressed on the specimen.

6.4 When testing materials that may be suspected of anisotropy, duplicate sets of test specimens shall be prepared having their long axes respectively parallel with, and normal to, the suspected direction of anisotropy.

7. Conditioning

7.1 *Conditioning*—Condition the test specimens at 23 ± 2°C and 50 ± 5 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D 618, for those tests where conditioning is required. In cases of disagreement, the tolerances shall be ±1°C and ±2 % relative humidity.

7.1.1 Note that for some hygroscopic materials, such as nylons, the material specifications (for example, Specification D 4066) call for testing "dry as-molded specimens." Such requirements take precedence over the above routine preconditioning to 50 % relative humidity and require sealing the specimens in water vapor-impermeable containers as soon as molded and not removing them until ready for testing.

7.2 *Test Conditions*—Conduct tests in the Standard Laboratory Atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity, unless otherwise specified in the test methods. In cases of disagreement, the tolerances shall be ±1°C and ± 2 % relative humidity.

NOTE 10—The tensile properties of some plastics change rapidly with small changes in temperature. Since heat may be generated as a result of straining the specimen at high rates, conduct tests without forced cooling to ensure uniformity of test conditions. Measure the temperature in the reduced section of the specimen and record it for materials where self-heating is suspected.

8. Number of Test Specimens

8.1 Test at least five specimens for each sample in the case of isotropic materials.

8.2 Test ten specimens, five normal to, and five parallel with, the principle axis of anisotropy, for each sample in case of anisotropic materials.

8.3 Discard specimens that break at some obvious fortuitous flaw, or that do not break between the predetermined gage marks, and make retests, unless such flaws constitute a variable to be studied.

NOTE 11—Before testing, all transparent specimens should be inspected in a polariscope. Those which show atypical or concentrated strain patterns should be rejected, unless the effects of these residual strains constitute a variable to be studied.

TABLE 1 Designation for Speed of Testing[A]

Classification[B]	Specimen Type	Speed of Testing, mm/min	Nominal Strain[C] Rate at Start of Test, mm/mm·min
Rigid and semirigid	M-I	5 ± 25 %	0.1
		50 ± 10 %	1
		500 ± 10 %	10
	M-II	5 ± 25 %	0.15
		50 ± 10 %	1.5
		500 ± 10 %	15
	M-III	1 ± 25 %	0.1
		10 ± 25 %	1
		100 ± 25 %	10
Nonrigid	M-II	50 ± 10 %	1.5
		500 ± 10 %	15

[A] Select the lowest speed that produces rupture in ½ to 5 min for the specimen geometry being used (see 9.2).

[B] See Definitions D 883 for definitions.

[C] The initial rate of straining cannot be calculated exactly for dumbbell-shaped specimens because of extension, both in the reduced section outside the gage length and in the fillets. This initial strain rate can be measured from the initial slope of the tensile strain-versus-time diagram.

9. Speed of Testing

9.1 Speed of testing shall be the relative rate of motion of the grips or test fixtures during the test. Rate of motion of the driven grip or fixture when the testing machine is running idle may be used, if it can be shown that the resulting speed of testing is within the limits of variation allowed.

9.2 Choose the speed of testing from Table 1. Determine this chosen speed of testing by the specification for the material being tested, or by agreement between those concerned. When the speed is not specified, use the lowest speed shown in Table 1 for the specimen geometry being used, which gives rupture within ½ to 5 min testing time.

9.3 Modulus determinations may be made at the speed selected for the other tensile properties or as required by the specification.

10. Procedure

10.1 Measure the width and thickness of rigid flat specimens (Fig. 1) with a suitable micrometer to the nearest 0.02 mm at several points along their narrow sections. Measure the thickness of nonrigid specimens (produced by a Type M-II die) in the same manner with the required dial micrometer. Take the width of this specimen as the distance between the cutting edges of the die in the narrow section. Record the minimum values of cross-sectional area so determined.

10.2 Place the specimen in the grips of the testing machine, taking care to align the long axis of the specimen and the grips with an imaginary line joining the points of attachment of the grips to the machine. The distance between the ends of the gripping surfaces, when using flat specimens, shall be as indicated in Fig. 1. Tighten the grips evenly and firmly to the degree necessary to prevent slippage of the specimen during the test but not to the point where the specimen would be crushed.

10.3 Attach the extension indicator. When modulus is being determined, the extension indicator must continuously record the distance the specimen is stretched (elongated) within the gage length as a function of the load through the initial (linear) portion of the load-elongation curve.

NOTE 12—Modulus of materials is determined from the slope of the linear portion of the stress-strain curve. For most plastics, this linear portion is very small, occurs very rapidly, and must be recorded automatically. The change in jaw separation is never to be used for calculating modulus or elongation.

10.4 Set the speed of testing at the proper rate as required in Section 9, and start the machine.

10.5 Record load-extension curve of the specimen.

10.6 Record the load and extension at the yield point (if one exists) and the load and extension at the moment of rupture.

NOTE 13—If it is desired to measure both modulus and failure properties (yield or break, or both), it may be necessary, in the case of highly extensible materials to run two independent tests. The high-magnification extensometer, normally used to determine properties up to the yield point, may not be suitable for tests involving high extensibility. If allowed to remain attached to the specimen, the extensometer could be permanently damaged. A broad-range incremental extensometer or hand rule technique may be needed when such materials are taken to rupture.

11. Calculation

11.1 *Tensile Strength*—Calculate the tensile strength by dividing the maximum load in newtons by the original minimum cross-sectional area of the specimen in square metres. Express the result in pascals and report it to three significant figures as tensile strength at yield or tensile strength at break, whichever term is applicable. When a nominal yield or break load less than the maximum is present and applicable, it may be desirable also to calculate, in a similar manner, the corresponding tensile stress at yield or tensile stress at break and report it to three significant figures (see Note A1.3).

11.2 *Percent Elongation*—If the specimen gives a yield load that is larger than the load at break, calculate percent elongation at yield. Otherwise, calculate percent elongation at break. Do this by reading the extension (change in gage length) at the moment the applicable load is reached. Divide that extension by the original gage length and multiply by 100. Report percent elongation at yield or percent elongation at break to two significant figures. When a yield or breaking load less than the maximum is present and of interest, it is desirable to calculate and report both percent elongation at yield and percent elongation at break (see Note A1.2).

11.3 *Modulus of Elasticity*—Calculate the modulus of elasticity by extending the initial linear portion of the load-extension curve and dividing the difference in stress corresponding to any segment of section on this straight line by the corresponding difference in strain. Compute all elastic modulus values using the average initial cross-sectional area of the test specimens in the calculations. Express the result in pascals and report to three significant figures.

11.4 For each series of tests, calculate the arithmetic mean of all values obtained and report it as the average value for the particular property in question.

11.5 Calculate the standard deviation (estimated) as follows and report it to two significant figures:

$$s = \sqrt{(\Sigma X^2 - n\bar{X}^2)/(n - 1)}$$

where:

s = estimated standard deviation,

X = value of single observation,

n = number of observations, and
$\bar{X}$ = arithmetic mean of the set of observations.

11.6 See Appendix X1 for information on toe compensation.

12. Report

12.1 Report the following information:

12.1.1 Complete identification of the material tested, including type, source, manufacturer's code numbers, form, principal dimensions, previous history, etc.,

12.1.2 Method of preparing test specimens,

12.1.3 Type of test specimen and dimensions,

12.1.4 Conditioning procedure used,

12.1.5 Atmospheric conditions in test room,

12.1.6 Number of specimens tested,

12.1.7 Speed of testing,

12.1.8 Tensile strength at yield or break, average value, and standard deviation,

12.1.9 Tensile stress at yield or break, if applicable, average value, and standard deviation,

12.1.10 Percent elongation at yield or break (or both as applicable), average value, and standard deviation,

12.1.11 Modulus of elasticity, average value, and standard deviation, and

12.1.12 Date of test.

13. Precision and Bias[7]

13.1 The precision and bias of this test method are under investigation by a task group of Section D20.10.22. Anyone wishing to participate in this work may contact the Chairman, Section D20.10.22, ASTM, 1916 Race Street, Philadelphia, PA 19103.

14. Keywords

14.1 metric; modulus of elasticity; percent elongation; plastics; tensile properties; tensile strength

[7] A report on a limited comparison between Methods D 638 and D 638M is available from ASTM Headquarters. Request RR:D20-1088.

ANNEX

(Mandatory Information)

A1. DEFINITIONS OF TERMS AND SYMBOLS RELATING TO TENSION TESTING OF PLASTICS

A1.1 *elastic limit*—the greatest stress which a material is capable of sustaining without any permanent strain remaining upon completed release of the stress. It is expressed in force per unit area, usually megapascals.

NOTE A1.1—Measured values of proportional limit and elastic limit vary greatly with the sensitivity and accuracy of the testing equipment, eccentricity of loading, the scale to which the stress-strain diagram is plotted, and other factors. Consequently, these values are usually replaced by yield strength.

A1.2 *elongation*—the increase in length produced in the gage length of the test specimen by a tensile load. It is expressed in units of length, usually millimetres. (Also known as *extension*.)

NOTE A1.2—Elongation and strain values are valid only in cases where uniformity of specimen behavior within the gage length is present. In the case of materials exhibiting necking phenomena, such values are only of qualitative utility after attainment of yield point. This is due to inability to assure that necking will encompass the entire length between the gage marks prior to specimen failure.

A1.3 *gage length*—the original length of that portion of the specimen over which strain or change in length is determined.

A1.4 *modulus of elasticity*—the ratio of stress (nominal) to corresponding strain below the proportional limit of a material. It is expressed in force per unit area, usually megapascals (also known as *elastic modulus* or *Young's modulus*).

NOTE A1.3—The stress-strain relations of many plastics do not conform to Hooke's law throughout the elastic range but deviate therefrom even at stresses well below the elastic limit. For such materials the slope of the tangent to the stress-strain curve at a low stress is usually taken as the modulus of elasticity. Since the existence of a true proportional limit in plastics is debatable, the propriety of applying the term "modulus of elasticity" to describe the stiffness or rigidity of a plastic has been seriously questioned. The exact stress-strain characteristics of plastic materials are very dependent on such factors as rate of stressing, temperature, previous specimen history, etc. However, such a value is useful if its arbitrary nature and dependence on time, temperature, and other factors are realized.

A1.5 *necking*—the localized reduction in cross section which may occur in a material under tensile stress.

A1.6 *offset yield strength*—the stress at which the strain exceeds by a specified amount (the offset) an extension of the initial proportional portion of the stress-strain curve. It is expressed in force per unit area, usually megapascals.

NOTE A1.4—This measurement is useful for materials whose stress-strain curve in the yield range is of gradual curvature. The offset yield strength can be derived from a stress-strain curve as follows (Fig. A1.1):

On the strain axis lay off *OM* equal to the specified offset.

Draw *OA* tangent to the initial straight-line portion of the stress-strain curve.

Through *M* draw a line *MN* parallel to *OA* and locate the intersection of *MN* with the stress-strain curve.

The stress at the point of intersection *r* is the "offset yield strength." The specified value of the offset must be stated as a percent of the original gage length in conjunction with the strength value. Example: 0.1 % offset yield strength = . . . MPa, or yield strength at 0.1 % offset = . . . MPa.

A1.7 *percent elongation*—the elongation of a test specimen expressed as a percent of the gage length.

A1.8 *percent elongation at break and yield:*

A1.8.1 *percent elongation at break*—the percent elongation at the moment of rupture of the test specimen.

A1.8.2 *percent elongation at yield*—the percent elonga-

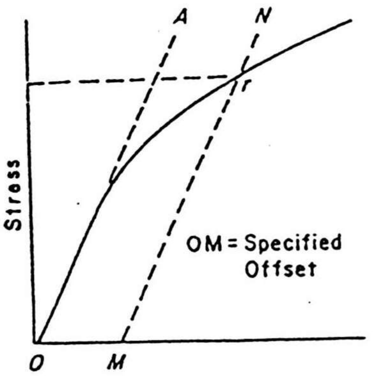


FIG. A1.1 Offset Yield Strength

tion at the moment the yield point (A1.21) is attained in the test specimen.

A1.9 *percent reduction of area (nominal)*—the difference between the original cross-sectional area measured at the point of rupture after breaking and after all retraction has ceased, expressed as a percent of the original area.

A1.10 *percent reduction of area (true)*—the difference between the original cross-sectional area of the test specimen and the minimum cross-sectional area within the gage boundaries prevailing at the moment of rupture, expressed as a percent of the original area.

A1.11 *proportional limit*—the greatest stress which a material is capable of sustaining without any deviation from proportionality of stress to strain (Hooke's law). It is expressed in force per unit area, usually megapascals.

A1.12 *rate of loading*—the change in tensile load carried by the specimen per unit time. It is expressed in force per unit time, usually newtons per minute. The initial rate of loading can be calculated from the initial slope of the load versus time diagram.

A1.13 *rate of straining*—the change in tensile strain per unit time. It is expressed either as strain per unit time, usually metres per metre per minute, or percent elongation per unit time, usually percent elongation per minute. The initial rate of straining can be calculated from the initial slope of the tensile strain-versus-time diagram.

NOTE A1.5—The initial rate of straining is synonymous with the rate of crosshead movement divided by the initial distance between crossheads only in a machine with constant-rate-of-crosshead movement and when the specimen has a uniform original cross-section, does not "neck down" and does not slip in the jaws.

A1.14 *rate of stressing (nominal)*—the change in tensile stress (nominal) per unit time. It is expressed in force per unit area per unit time, usually megapascals per minute. The initial rate of stressing can be calculated from the initial slope of the tensile stress (nominal) versus time diagram.

NOTE A1.6—The initial rate of stressing as determined in this manner has only limited physical significance. It does, however, roughly describe the average rate at which the initial stress (nominal) carried by the test specimen is applied. It is affected by the elasticity and flow characteristics of the materials being tested. At the yield point, the rate of stressing (nominal) may become zero, but the rate of stressing (true) may continue to have a positive value if the cross-sectional area is decreasing.

A1.15 *secant modulus*—the ratio of stress (nominal) to corresponding strain at any specified point on the stress-strain curve. It is expressed in force per unit area, usually megapascals and reported together with the specified stress or strain.

NOTE A1.7—This measurement is usually employed in place of modulus of elasticity in the case of materials whose stress-strain diagram does not demonstrate proportionality of stress to strain.

A1.16 *strain*—the ratio of the elongation to the gage length of the test specimen, that is, the change in length per unit of original length. It is expressed as a dimensionless ratio.

A1.17 *tensile strength (nominal)*—the maximum tensile stress (nominal) sustained by the specimen during a tension test. When the maximum stress occurs at the yield point (A1.21), it shall be designated tensile strength at yield. When the maximum stress occurs at break, it shall be designated tensile strength at break.

A1.18 *tensile stress (nominal)*—the tensile load per unit area of minimum original cross section, within the gage boundaries, carried by the test specimen at any given moment. It is expressed in force per unit area, usually megapascals.

NOTE A1.8—The expression of tensile properties in terms of the minimum original cross-section is almost universally used in practice. In the case of materials exhibiting high extensibility, or necking, or both (A1.5), nominal stress calculations may not be meaningful beyond the yield point (A1.21) due to the extensive reduction in cross-sectional area that ensues. Under some circumstances it may be desirable to express the tensile properties per unit of minimum prevailing cross section. These properties are called true tensile properties (that is, true tensile stress, etc.).

A1.19 *tensile stress-strain curve*—a diagram in which values of tensile stress are plotted as ordinates against corresponding values of tensile strain as abscissas.

A1.20 *true strain* (see Fig. A1.2) is defined by the following equation for ϵ_T:

$$\epsilon_T = \int_{L_o}^{L} dL/L = \ln L/L_o$$

where:

dL = the increment of elongation when the distance between the gage marks is L,

L_o = the original distance between gage marks, and

L = the distance between gage marks at any time.

A1.21 *yield point*—the first point on the stress-strain curve at which an increase in strain occurs without an increase in stress (Fig. A1.3).

NOTE A1.9—Only materials whose stress-strain curves exhibit a point of zero slope may be considered as having a yield point.

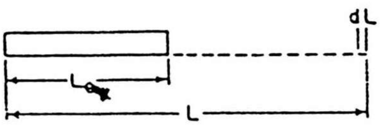


FIG. A1.2 Illustration of True Strain Equation

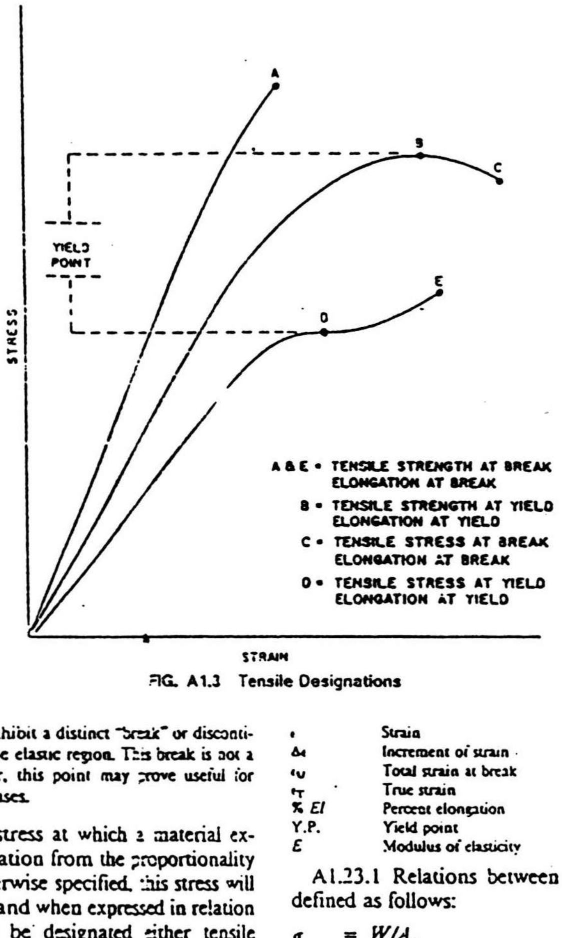


FIG. A1.3 Tensile Designations

NOTE A1.10—Some materials exhibit a distinct "break" or discontinuity in the stress-strain curve in the elastic region. This break is not a yield point by definition. However, this point may prove useful for material characterization in some cases.

A1.22 *yield strength*—the stress at which a material exhibits a specified limiting deviation from the proportionality of stress to strain. Unless otherwise specified, this stress will be the stress at the yield point and when expressed in relation to the tensile strength shall be designated either tensile strength at yield or tensile stress at yield as required under A1.17 (Fig. A1.3). (See *offset yield strength*.)

A1.23 *Symbols*—The following symbols may be used for the above terms:

Symbol	Term
W	Load
ΔW	Increment of load
L	Distance between gage marks at any time
L_o	Original distance between gage marks
L_u	Distance between gage marks at moment of rupture
ΔL	Increment of distance between gage marks = elongation
A	Minimum cross-sectional area at any time
A_o	Original cross-sectional area
ΔA	Increment of cross-sectional area
A_u	Cross-sectional area at point of rupture measured after breaking specimen
A_T	Cross-sectional area at point of rupture, measured at the moment of rupture
t	Time
Δt	Increment of time
σ	Tensile stress
$\Delta\sigma$	Increment of stress
σ_T	True tensile stress
σ_U	Tensile strength at break (nominal)
σ_{UT}	Tensile strength at break (true)
ϵ	Strain
$\Delta\epsilon$	Increment of strain
ϵ_U	Total strain at break
ϵ_T	True strain
% El	Percent elongation
Y.P.	Yield point
E	Modulus of elasticity

A1.23.1 Relations between these various terms may be defined as follows:

$\sigma = W/A_o$

$\sigma_T = W/A$

$\sigma_U = W/A_o$ (where W is breaking load)

$\sigma_{UT} = W/A_T$ (where W is breaking load)

$\epsilon = \Delta L/L_o = (L - L_o)/L_o$

$\epsilon_U = (L_u - L_o)/L_o$

$$\epsilon_T = \int_{L_o}^{L} dL/L = \ln L/L_o$$

$\% El = [(L - L_o)/L_o] \times 100 = \epsilon \times 100$

Percent reduction of area (nominal) = $[(A_o - A_u)/A_o] \times 100$

Percent reduction of area (true) = $[(A_o - A_T)/A_o] \times 100$

Rate of loading = $\Delta W/\Delta t$

Rate of stressing (nominal) = $\Delta\sigma/\Delta t = (\Delta W/A_o)/\Delta t$

Rate of straining = $\Delta\epsilon/\Delta t = (\Delta L/L_o)/\Delta t$

For the case where the volume of the test specimen does not change during the test, the following three relations hold:

$\sigma_T = \sigma(1 + \epsilon) = \sigma L/L_o$

$\sigma_{UT} = \sigma_U(1 + \epsilon_U) = \sigma_U L_u/L_o$

$A = A_o/(1 + \epsilon)$

APPENDIX

(Nonmandatory Information)

X1. TOE COMPENSATION

X1.1 In a typical stress-strain curve (Fig. X1.1) there is a toe region, *AC*, which does not represent a property of the material. It is an artifact caused by a takeup of slack, and alignment or seating of the specimen. In order to obtain correct values of such parameters as modulus, strain, and offset yield point, this artifact must be compensated for to give the corrected zero point on the strain or extension axis.

X1.2 In the case of a material exhibiting a region of Hookean (linear) behavior (Fig. X1.1), a continuation of the linear (*CD*) region of the curve is constructed through the zero-stress axis. This intersection (*B*) is the corrected zero-strain point from which all extensions or strains must be measured, including the yield offset (*BE*), if applicable. The elastic modulus can be determined by dividing the stress at any point along the line *CD* (or its extension) by the strain at the same point (measured from point *B*, defined as zero-strain).

X1.3 In the case of a material which does not exhibit any linear region (Fig. X1.2), the same kind of toe correction of the zero-strain point can be made by constructing a tangent to the maximum slope at the inflection point (*H'*). This is extended to intersect the strain axis at point *B'*, the corrected zero-strain point. Using point *B'* as zero strain, the stress at any point (*G'*) on the curve can be divided by the strain at that point to obtain a secant modulus (slope of line *B' G'*). For these materials with no linear region, any attempt to use the tangent through the inflection point as a basis for determination of an offset yield point may result in unacceptable error.

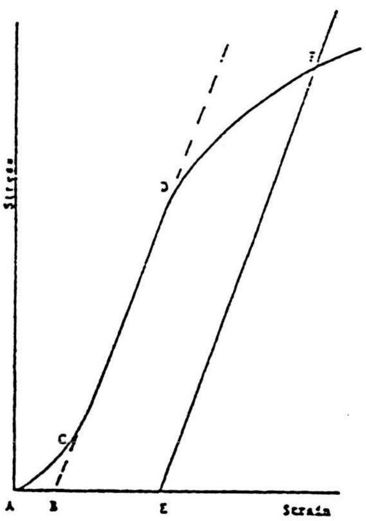


FIG. X1.1 Material with Hookean Region

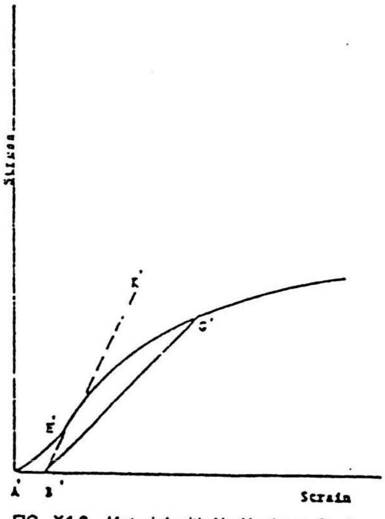


FIG. X1.2 Material with No Hookean Region
(Note that some chart recorders plot the mirror image of these graphs.)

APPENDIX B

Graph of mechanical properties predicted by Simplex equation

B.1 Modulus of polymer blends

PEK-C/PSF blend

w.fraction	experiment	equation
0	2.07	2.07
0.1	2.20	2.22
0.2		2.35
0.3	2.43	2.46
0.4		2.57
0.5	2.65	2.65
0.6		2.72
0.7	2.78	2.77
0.8		2.81
0.9	2.81	2.83
1	2.84	2.84

Interaction parameter	0.78

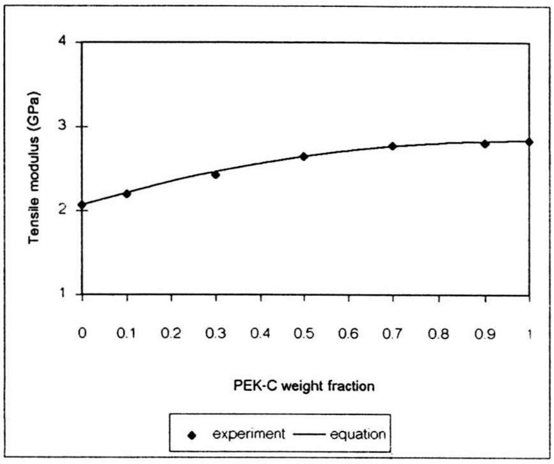


Fig. B.1.1 Tensile modulus of PEK-C/PSF blend [72]

PA/PC

w.fraction	experiment	equation
0	2105	2105
0.05	2186	2129
0.25	2236	2190
0.3		2196
0.4	2222	2198
0.5	2186	2186
0.6	2318	2160
0.75	2127	2094
0.8		2065
0.9	1968	1996
1	1913	1913

Interaction parameter	708.00

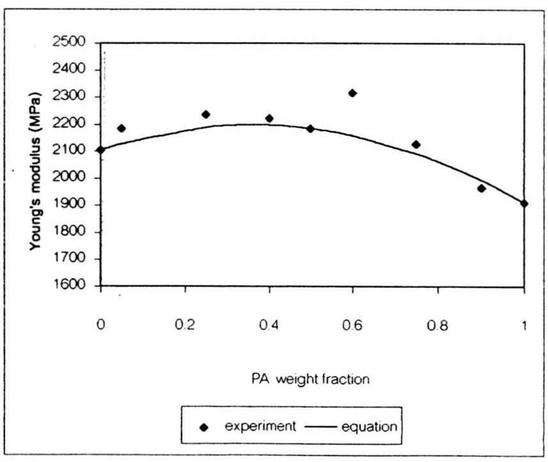


Fig. B.1.2 Young's modulus of PA/PC blend [26]

EVOH-71/Nylon-6 blend

w.fraction	experiment	equation
0	2.3	2.30
0.1	2.5	2.47
0.2		2.63
0.3	2.8	2.79
0.4		2.95
0.5	3.1	3.10
0.6		3.25
0.7	3.4	3.39
0.8		3.53
0.9	3.6	3.67
1	3.8	3.80

Interaction parameter	0.20

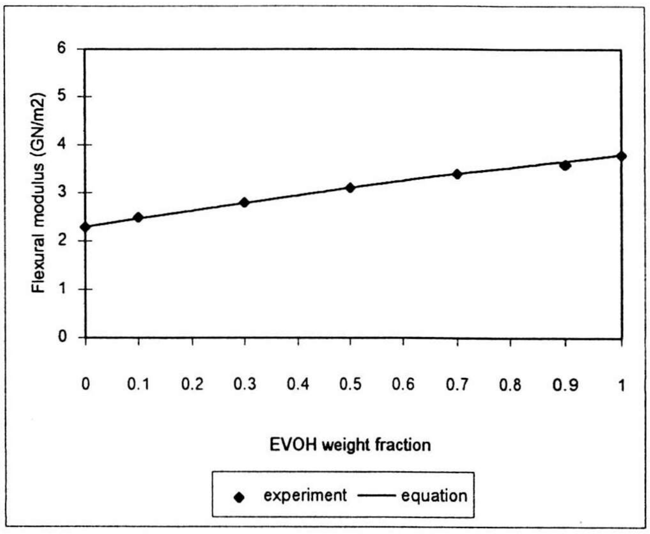


Fig. B.1.3 Flexural modulus of EVOH-71/ Nylon-6 blend [28]

PP/ULDPE blend

w.fraction	experiment	equation
0	1470	1470
0.05	1230	1354
0.2	1095	1034
0.3	720	845
0.4		676
0.5	525	525
0.6		394
0.7	300	281
0.8		188
0.9	105	115
1	60	60

Interaction parameter	-960.00

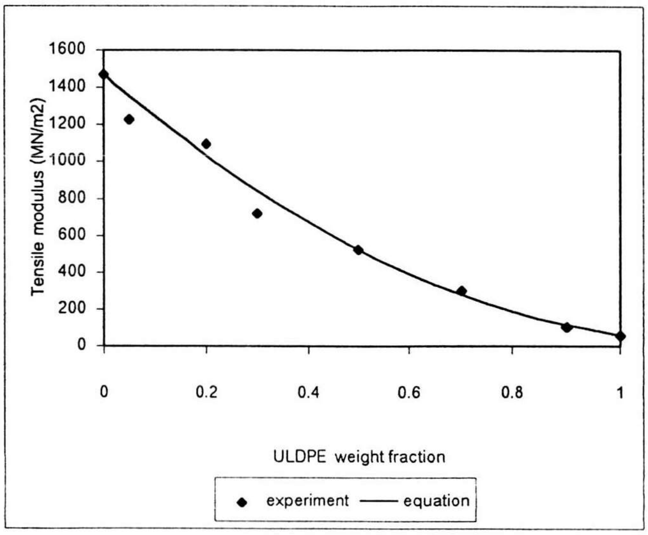


Fig. B.1.4 Flexural modulus of PP/ULDPE blend [29]

PC/PAr blend

w.fraction	experiment	equation
1	2.29	2.29
0.9		2.28
0.85	2.26	2.28
0.7	2.22	2.26
0.6		2.24
0.5	2.22	2.22
0.4		2.19
0.3	2.17	2.15
0.2		2.11
0.15	2.08	2.09
0	2.02	2.02

Interaction parameter	0.24

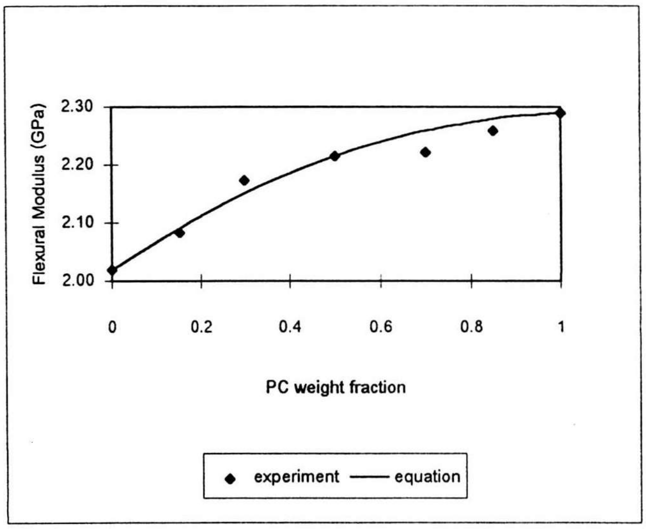


Fig. B.1.5 Flexural modulus of PC/PAr blend [73]

PBT/PAr blend

w.fraction	experiment	equation
100%	1835	1835
0.9		1921
0.8		1991
0.7		2046
0.6		2086
0.5	2110	2110
0.4	2157	2119
0.3	2157	2112
0.2	2033	2090
0.1	2065	2053
0	2000	2000

Interaction parameter	770

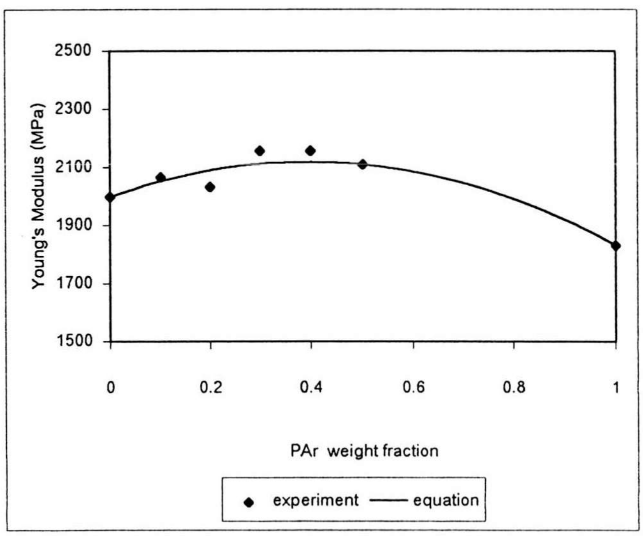


Fig. B.1.6 Young's modulus of PBT/PAr blend [74]

PEEK/Polyether sulfone blend

w.fraction	experiment	equation
0	2160	2160
0.15	2138	2138
0.2		2138
0.3	2138	2146
0.4		2166
0.5	2200	2200
0.6		2246
0.7	2300	2306
0.85	2358	2418
0.9		2462
1	2560	2560

Interaction parameter	-640

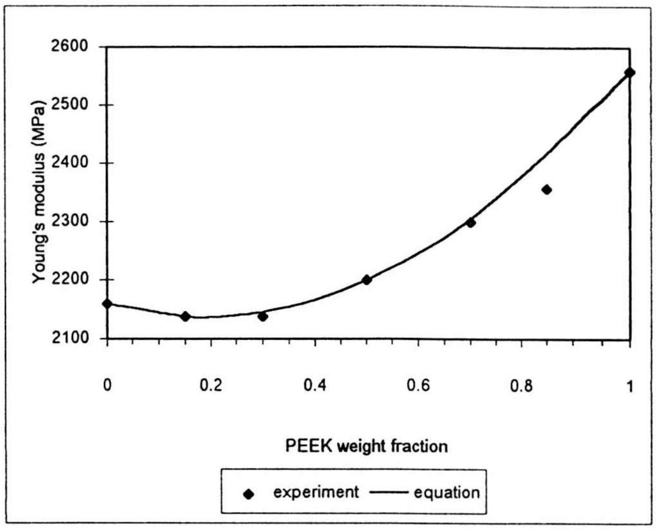


Fig. B.1.7 Young's modulus of PEEK/Polyethersulfone blend [75]

PP/PA6 blend

w.fraction	experiment	equation
0	11.5	11.5
0.1		11.6
0.25	12.3	12.0
0.3		12.2
0.4	12.8	12.7
0.5	13.4	13.4
0.6	14.4	14.2
0.75	15.5	15.7
0.8		16.3
0.9		17.6
1	19.0	19.0

Interaction parameter	-7.4

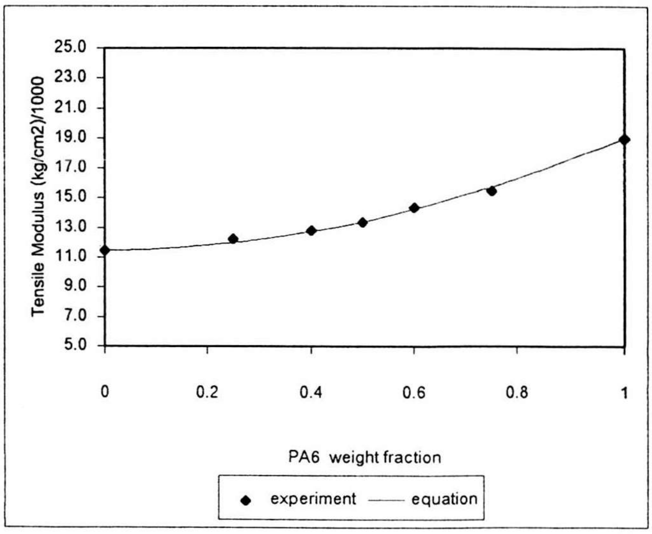


Fig. B.1.8 Young's modulus of PP/PA6 blend [26]

PAr/PA6 blend

w.fraction	experiment	equation
0	2.5	2.50
0.1	2.2	1.95
0.2		1.54
0.3	1.7	1.29
0.4		1.20
0.5	1.3	1.25
0.6		1.46
0.7	1.5	1.81
0.8		2.32
0.9	3.1	2.99
1	3.8	3.80

Interaction parameter	-7.6

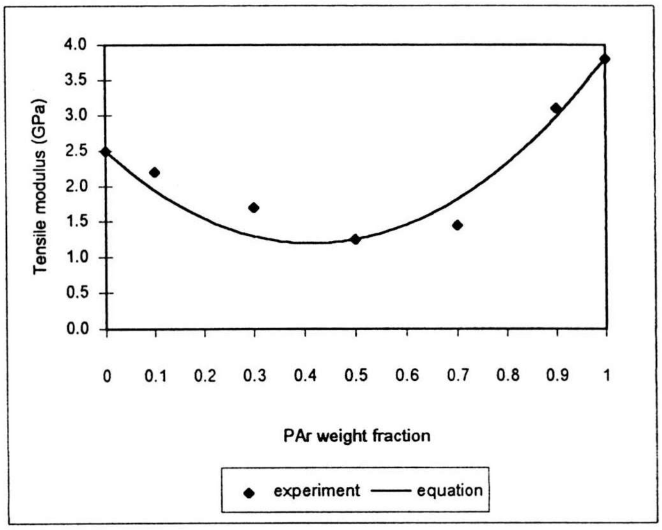


Fig B.1.9 Tensile modulus of PAr/PA6 blend [36]

PMMA/Phenoxy blend

w.fraction	experiment	equation
0	31300	31300
0.1	30000	30440
0.2		29660
0.3	28500	28960
0.4		28340
0.5	27800	27800
0.6		27340
0.7	27600	26960
0.8		26660
0.9	26600	26440
1	26300	26300

Interaction parameter	-4000

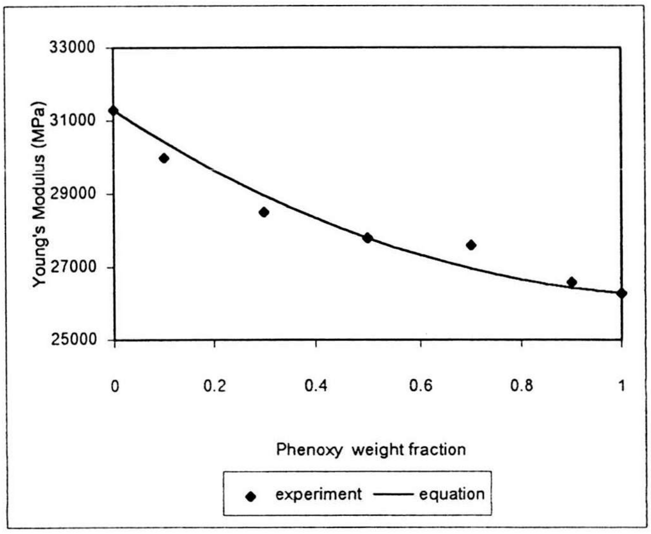


Fig. B.1.10 Tensile modulus of PMMA/Phenoxy blend [37]

PHB/PVC blend

w.fraction	experiment	equation
0	7.125	7.125
0.1		6.9
0.2	11.625	7.05
0.3	11.25	7.575
0.4		8.475
0.5	9.75	9.75
0.6		11.4
0.7	15.75	13.425
0.8	18.375	15.825
0.9		18.6
1	21.75	21.75

Interaction parameter	-18.75

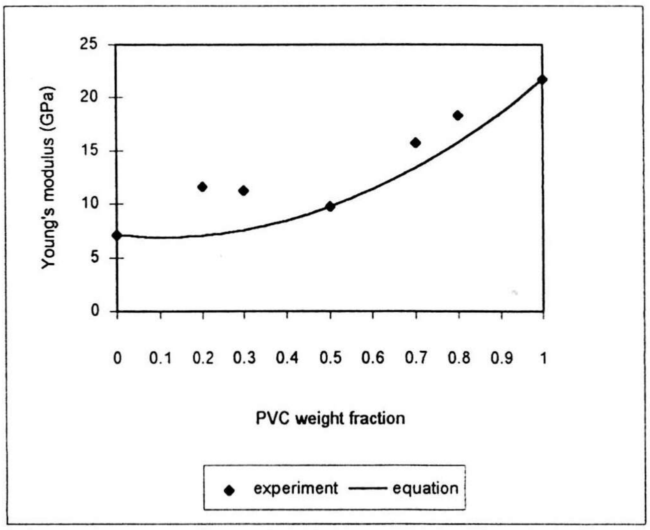


Fig. B.1.11 Tensile modulus of PHB/PVC blend [38]

Nylon6/PP

w.fraction	experiment	equation
0	2.80	2.80
0.1	2.50	2.69
0.2	2.60	2.56
0.3	2.35	2.41
0.4		2.24
0.5	2.05	2.05
0.6		1.84
0.7	1.85	1.61
0.8		1.36
0.9	1.10	1.09
1	0.80	0.80

Interaction parameter	1

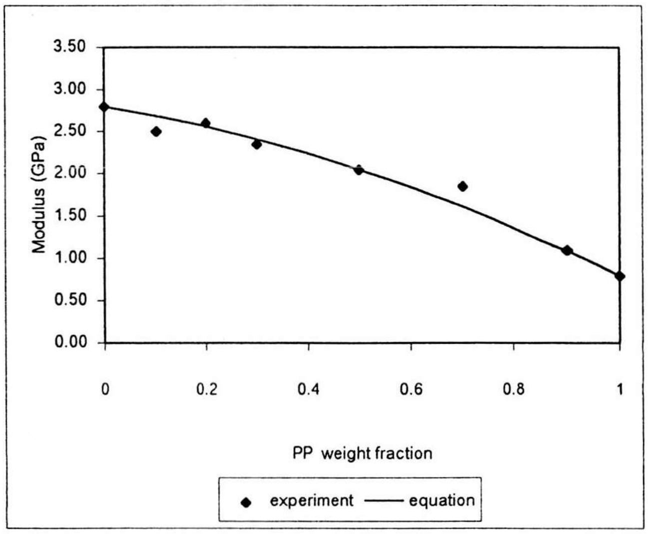


Fig. B.1.12 Modulus of Nylon-6/Polypropylene blend [39]

PP/NBR blend

w.fraction	experiment	equation
0	500	500
0.1		408
0.2		326
0.3	250	253
0.4		189
0.5	135	135
0.6		90
0.7	47	54
0.8		27
0.9		10
1	1.5	2

Interaction parameter	-463

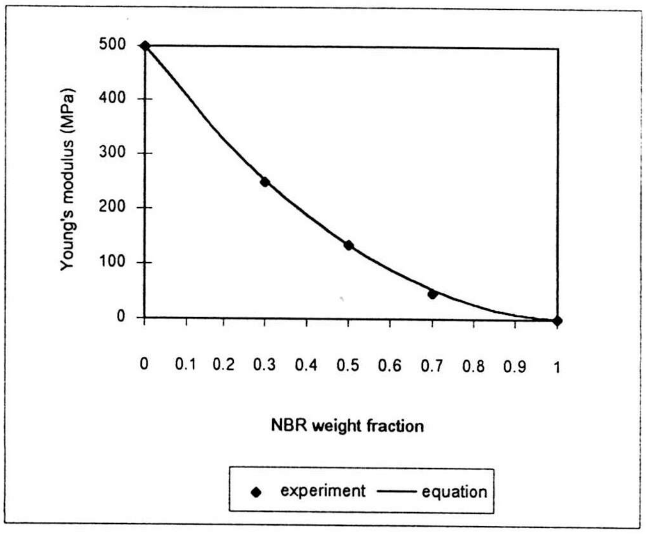


Fig. B.1.13 Tensile modulus of PP/NBR blend [40]

PES/PMIA

w.fraction	experiment	equation
0	2.5	2.50
0.1		2.67
0.2	2.5	2.83
0.3		2.99
0.4	3.2	3.15
0.5	3.3	3.30
0.6	3.3	3.45
0.7	3.6	3.59
0.8		3.73
0.9		3.87
1	4.0	4.00

Interaction parameter	0.20

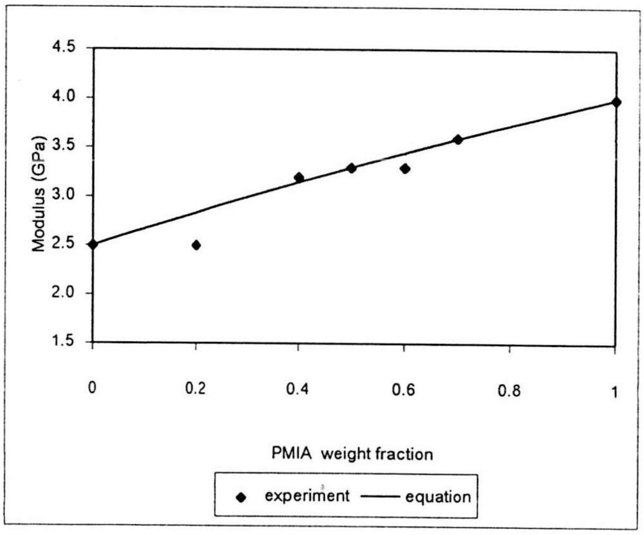


Fig. B.1.14 Modulus of PES/PMIA blend [41]

PPS/PSF blend

w.fraction	experiment	equation
0	1690	1690
0.1		1635
0.2		1591
0.3	1619	1557
0.4		1534
0.5	1522	1522
0.6		1520
0.7	1530	1529
0.8		1548
0.9		1578
1	1619	1619

Interaction parameter	-530

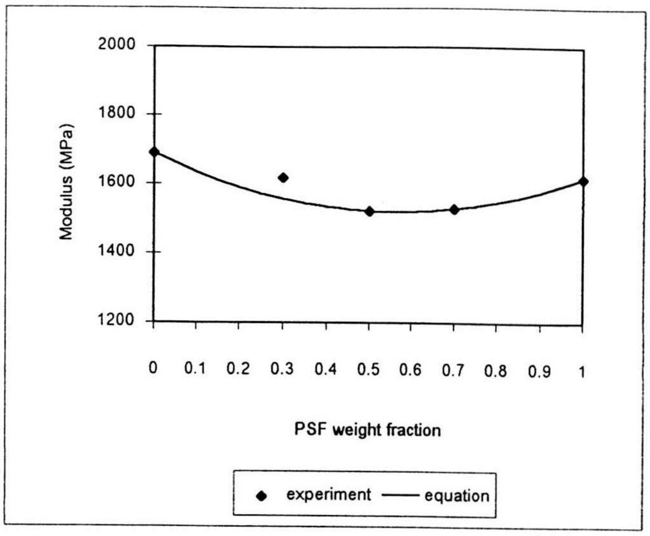


Fig. B.1.15 Tensile modulus of PPS/PSF blend [42]

PP/LPC(Vectra)

w.fraction	experiment	equation
0	10.99	10.99
0.1		10.04
0.2	8.99	9.08
0.3		8.12
0.4		7.16
0.5	6.16	6.19
0.6		5.23
0.7	2.70	4.26
0.8	2.16	3.30
0.9		2.33
1	1.36	1.36

Interaction parameter	-0.072

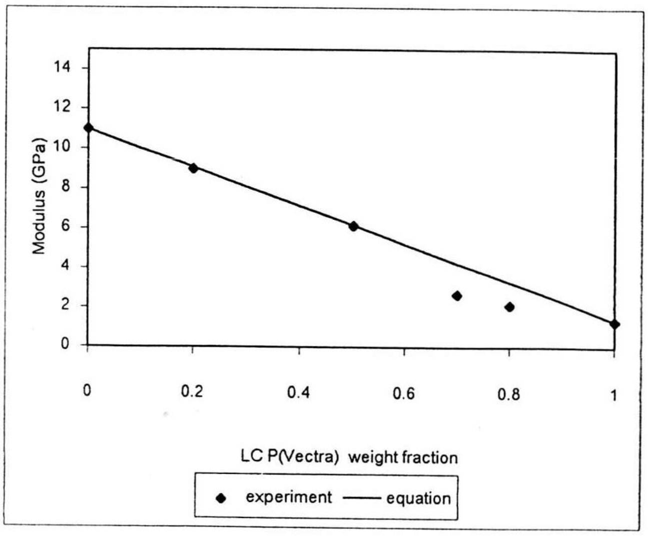


Fig. B.1.16 Modulus of PP/LCP(Vectra) blend [43]

PC/CAB blend

w.fraction	experiment	equation
0	2485	2485
0.1		2532
0.2	2489	2547
0.3		2530
0.4	2489	2481
0.5	2400	2400
0.6	2190	2287
0.7		2142
0.8	2002	1965
0.9		1757
1	1516	1516

Interaction parameter	1598

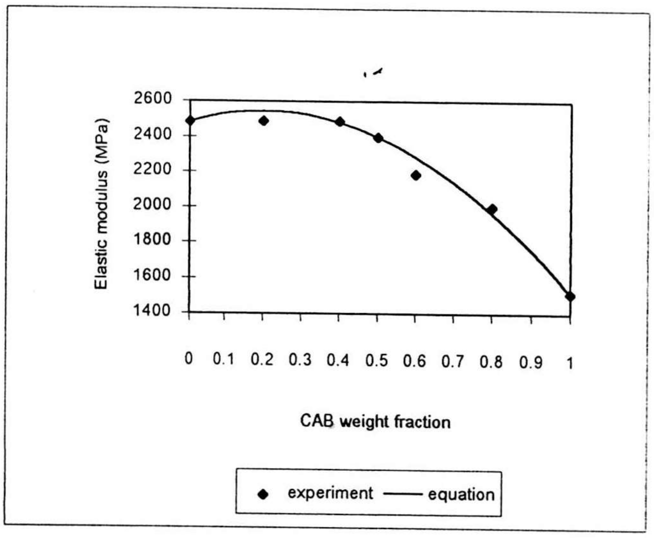


Fig. B.1.17 Tensile modulus of PC/CAB blend [44]

SBS/MS(200) blend

w.fraction	experiment	equation
0	1500	1500
0.1		1602
0.2		1718
0.25	1750	1781
0.4		1992
0.5	2150	2150
0.6		2322
0.7		2508
0.75	2750	2606
0.9		2922
1	3150	3150

Interaction parameter	-700

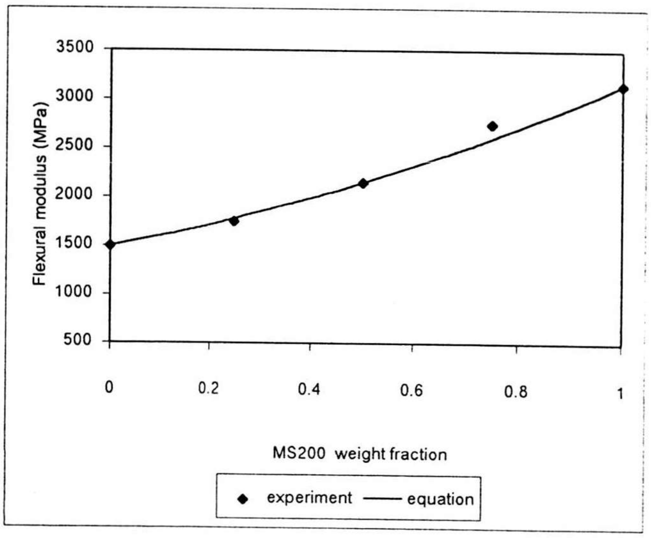


Fig. B.1.18 Flexural modulus of SBS/MS200 blend [45]

PEI/PET blend

w.fraction	experiment	equation
0	2100	2100
0.1		2206
0.25	2430	2349
0.3		2392
0.4		2470
0.5	2540	2540
0.6		2600
0.75	2690	2674
0.8		2694
0.9		2726
1	2750	2750

Interaction parameter	460

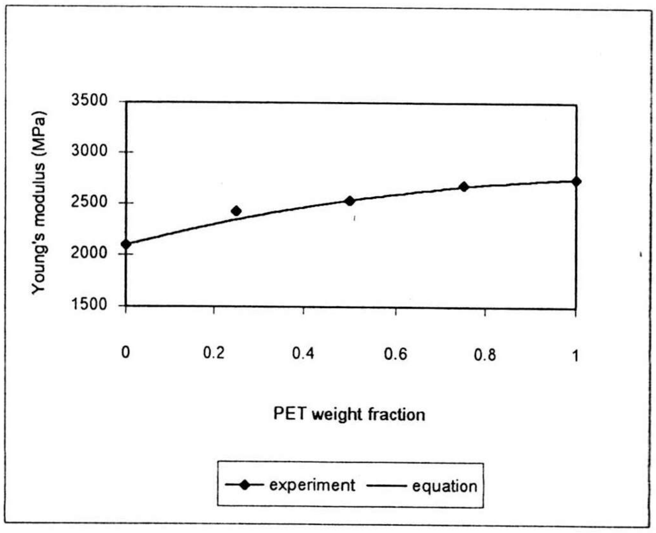


Fig. B.1.19 Young's modulus of PEI/PET blend [48]

HDPE/LDPE blend

w.fraction	experiment	equation
0	7.8	7.8
0.1	10.5	10.4
0.2	12.8	12.7
0.35	13.9	15.8
0.4		16.7
0.5	18.3	18.3
0.65	20.0	20.3
0.7		20.8
0.8	21.4	21.7
0.9	21.7	22.4
1	22.8	22.8

Interaction parameter	12.00

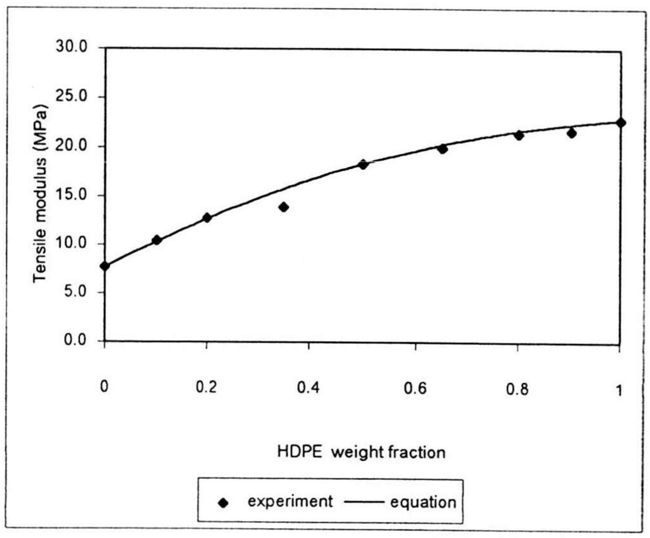


Fig. B.1.20 Tensile modulus of HDPE/LDPE blend [49]

LLDPE/PP blend

w.fraction	experiment	equation
0	4.5	4.50
0.1	3.9	4.11
0.2	3.5	3.72
0.3		3.34
0.4		2.97
0.5	2.6	2.60
0.6		2.24
0.7		1.88
0.8	1.7	1.53
0.9	0.9	1.19
1	0.9	0.85

Interaction parameter	-0.30

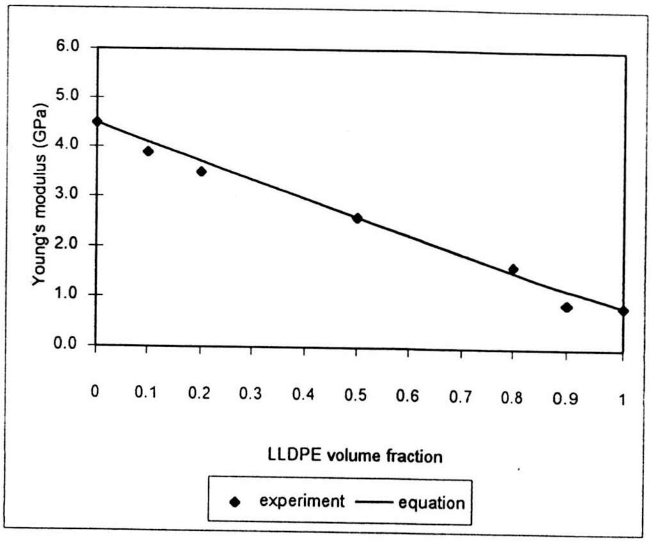


Fig. B.1.21 Young's modulus of LLDPE/PP blend [30]

LLDPE/PP blend

w.fraction	experiment	equation
0	0.22	0.22
0.1		0.42
0.2	0.69	0.59
0.3		0.74
0.4	0.94	0.87
0.5	0.97	0.97
0.6		1.05
0.7		1.10
0.8	1.08	1.12
0.9		1.12
1	1.10	1.10

Interaction parameter	1.24

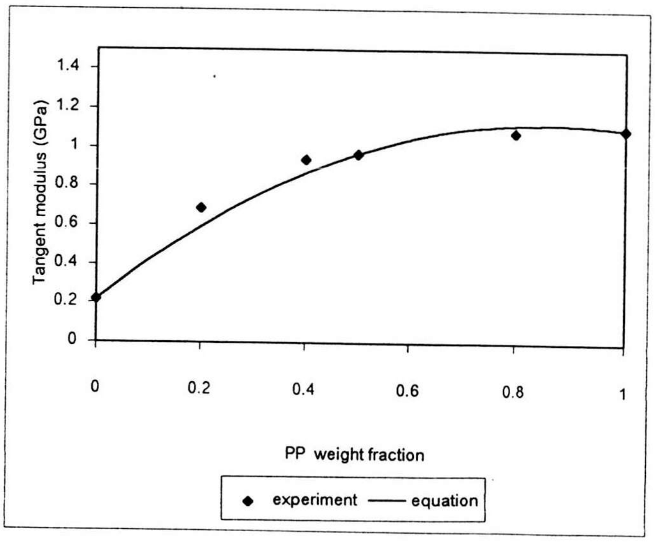


Fig. B.1.22 Tangent modulus of LLDPE/PP blend [51]

PC/LLDPE blend

w.fraction	experiment	equation
0	0.15	0.15
0.1		0.20
0.25	0.31	0.29
0.3		0.32
0.4		0.41
0.5	0.50	0.50
0.6		0.61
0.75	0.83	0.79
0.8		0.85
0.9		1.00
1	1.15	1.15

Interaction parameter	-0.6

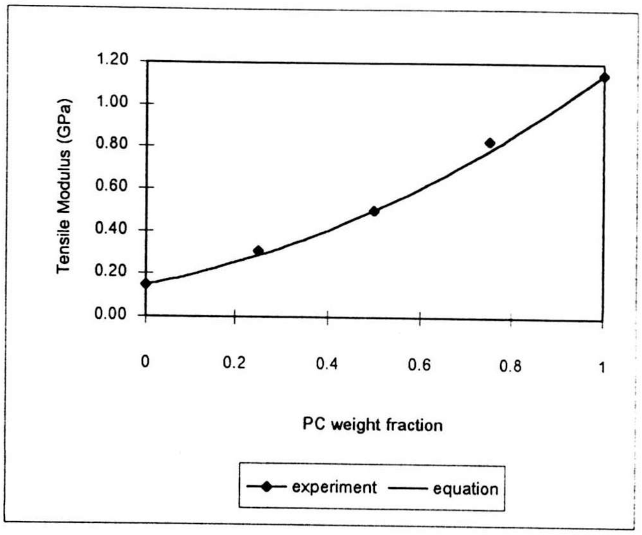


Fig. B.1.23 Young's modulus of PC/LLDPE blend [52]

PC/ABS blend

w.fraction	experiment	equation
0	350	7.80
0.1	10.5	10.38
0.2	12.8	12.72
0.3	13.9	14.82
0.4		16.68
0.5	18.3	18.30
0.6	20	19.68
0.7		20.82
0.8	21.4	21.72
0.9	21.7	22.38
1	22.8	22.80

Interaction parameter	-672.40

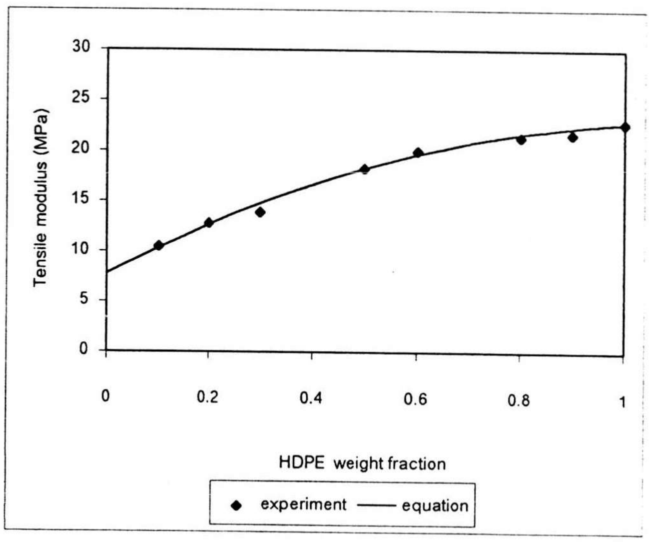


Fig. B.1.24 Young's modulus of PC/ABS blend [53]

PC/Copolyester blend

w.fraction	experiment	equation
0	350	350
0.1		342
0.2	340	332
0.3		322
0.4	320	312
0.5	300	300
0.6	290	288
0.7		274
0.8	270	260
0.9		246
1	230	230

Interaction parameter	40

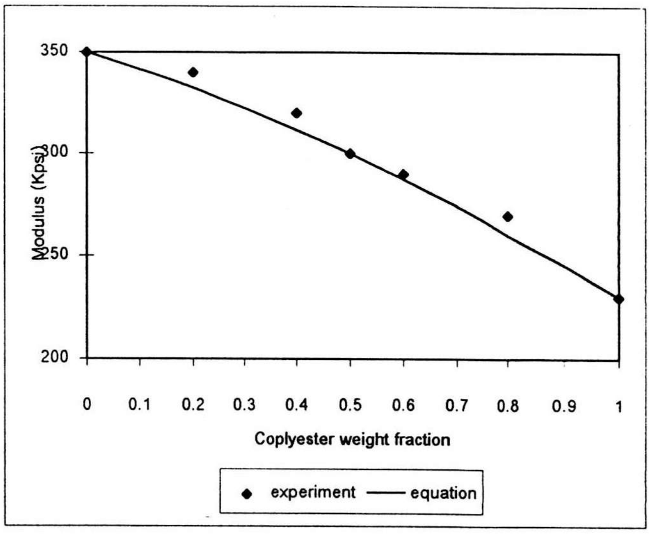


Fig. B.1.25 Modulus of PC/Copolyester blend [54]

PA6/PP blend

w.fraction	experiment	equation
0	1320	1320
0.1		1443
0.2	1500	1564
0.3		1683
0.4	1890	1800
0.5	1915	1915
0.6	1940	2028
0.7		2139
0.8	2200	2248
0.9		2355
1	2460	2460

Interaction parameter	100.00

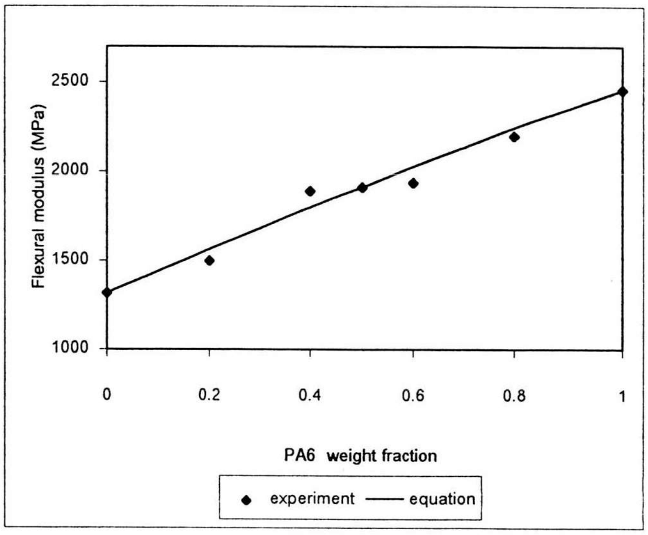


Fig. B.1.26 Flexural modulus of PA6/PP blend [55]

PS/HDPE blend

w.fraction	experiment	equation
0	1.8	1.80
0.1		1.98
0.25	2.5	2.31
0.3		2.44
0.4		2.70
0.5	3.0	3.00
0.6		3.32
0.75	3.9	3.86
0.8		4.06
0.9		4.46
1	4.9	4.90

Interaction parameter	-1.4

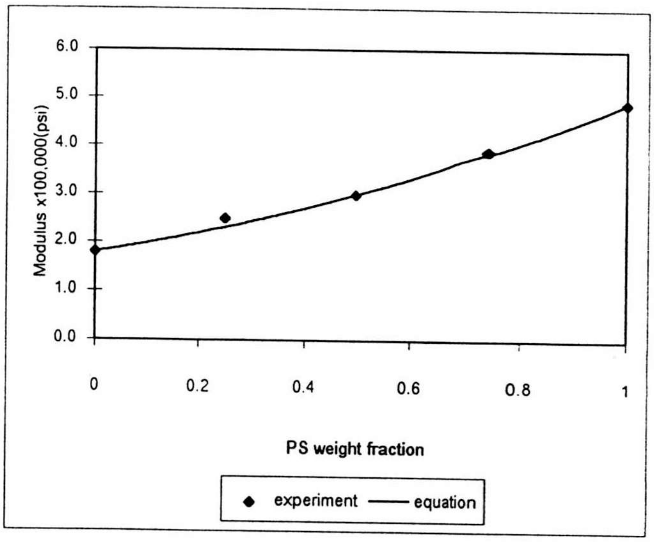


Fig. B.1.27 Modulus of PS/HDPE blend [65]

ABS/PC blend

w.fraction	experiment	equation
0	311.3	311.3
0.15	313.1	312.3
0.25	314.4	313.1
0.3		313.7
0.4	315.6	315.1
0.5	317.0	317.0
0.6	320.6	319.3
0.75	324.1	323.6
0.85	327.2	327.0
0.9		328.9
1	333.0	333.0

Interaction parameter	-20.5

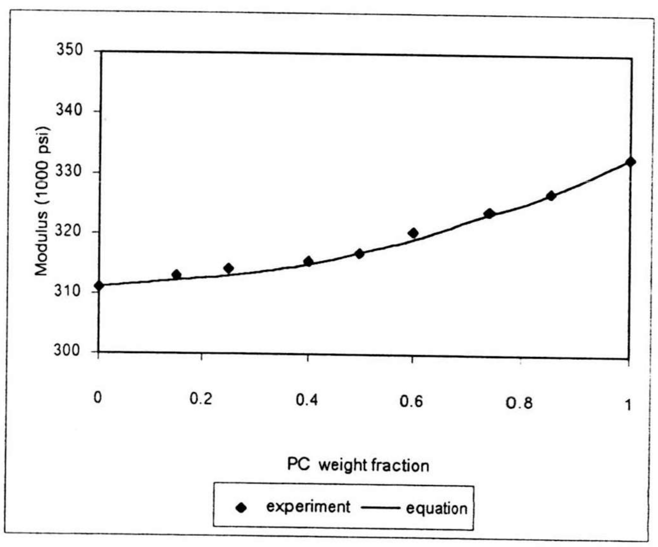


Fig. B.1.28 Modulus of ABS/PC blend [66]

HIPS/ABS blend

w.fraction	experiment	equation
0	1.10	1.10
0.1		1.08
0.25	1.06	1.06
0.3		1.05
0.4		1.04
0.5	1.03	1.02
0.6		1.01
0.75	0.98	0.98
0.8		0.98
0.9		0.96
1	0.95	0.95

Interaction parameter	0.02

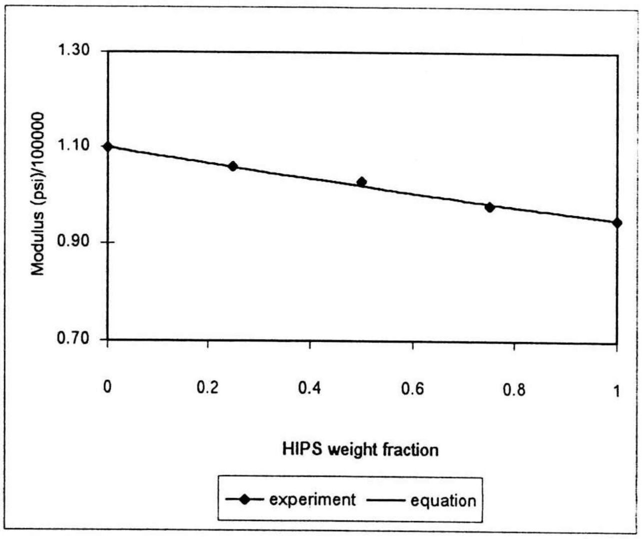


Fig. B.1.29 Modulus of HIPS/ABS blend [67]

PC/SAN blend

w.fraction	experiment	equation
0	4.55	4.55
0.1		4.37
0.2	4.10	4.21
0.3		4.05
0.4		3.91
0.5	3.77	3.77
0.6		3.65
0.7		3.53
0.8	3.30	3.43
0.9		3.33
1	3.25	3.25

Interaction parameter	-0.52

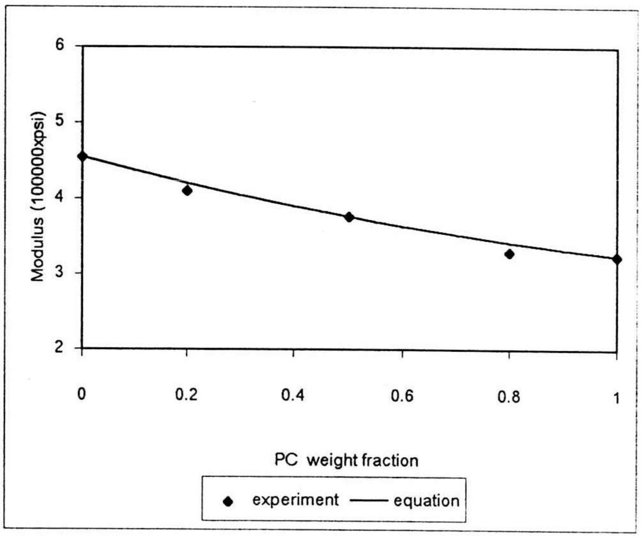


Fig. B.1.30 Modulus of PC/SAN blend [68]

PC/PET blend

w.fraction	experiment	equation
0	343750	343750
0.1	330000	339600
0.25	327500	335156
0.35	333500	333381
0.4		332850
0.5	332500	332500
0.6	328500	333100
0.7	342500	334650
0.8	340000	337150
0.9	340000	340600
1	345000	345000

Interaction parameter	-47500

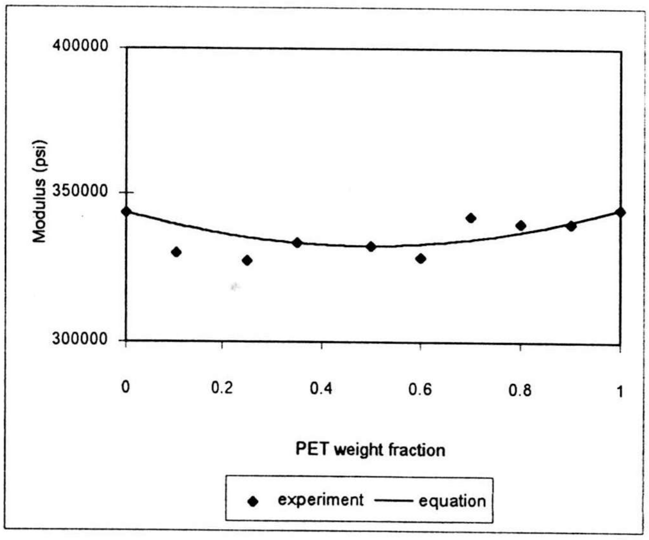


Fig. B.1.31 Modulus of PC/PET blend [69]

HDPE/PP blend

w.fraction	experiment	equation
0	2.50	2.50
0.1		2.45
0.25	2.35	2.36
0.3		2.33
0.4		2.27
0.5	2.20	2.20
0.6		2.13
0.75	2.00	2.01
0.8		1.97
0.9		1.89
1	1.80	1.80

Interaction parameter	0.20

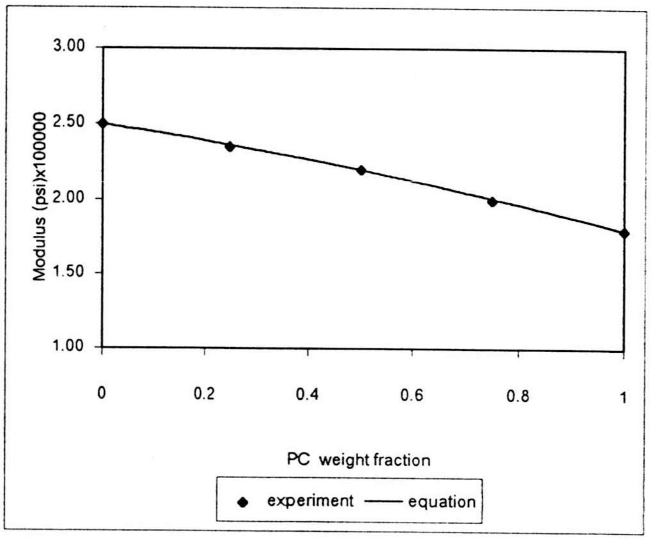


Fig. B.1.32 Modulus of HDPE/PP blend [70]

PUR/PEMA blend

w.fraction	experiment	equation
0	870	870.0
0.1	770	651.3
0.2	500	462.0
0.3	300	301.9
0.4	210	171.0
0.5	70	69.5
0.6	39	-2.8
0.7	8	-45.7
0.8	3.3	-59.4
0.9	1.3	-43.9
1	1	1.0

Interaction parameter	-1462

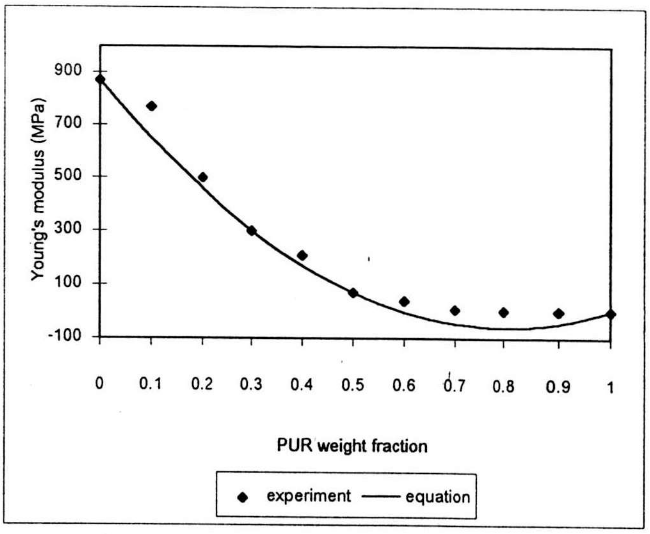


Fig. B.1.33 Young's modulus of PUR/PEMA blend [50]

LLDPE/PP blend

w.fraction	experiment	equation
0	4.5	4.50
0.1	3.9	4.11
0.2	3.5	3.72
0.3		3.34
0.4		2.97
0.5	2.6	2.60
0.6		2.24
0.7		1.88
0.8	1.7	1.53
0.9	0.9	1.19
1	0.9	0.85

Interaction parameter	-0.30

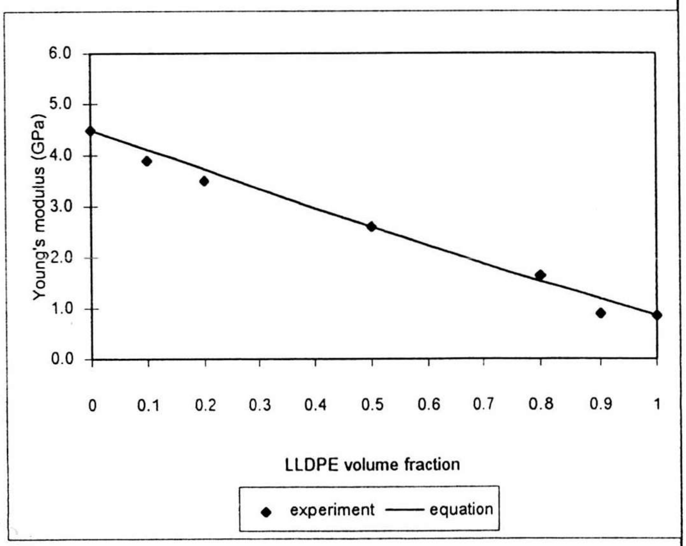


Fig. B.1.34 Young's modulus of LLDPE/PP blend [60]

B.2 Impact strength of polymer blends

EVOH-71/Nylon-6 blend

w.fraction	experiment	equation
0	29.68	29.68
0.1	23.20	25.19
0.2		21.26
0.3	12.26	17.91
0.4		15.12
0.5	12.90	12.90
0.6		11.25
0.7	14.19	10.16
0.8		9.65
0.9	8.40	9.70
1	10.32	10.32

Interaction parameter	-28.40

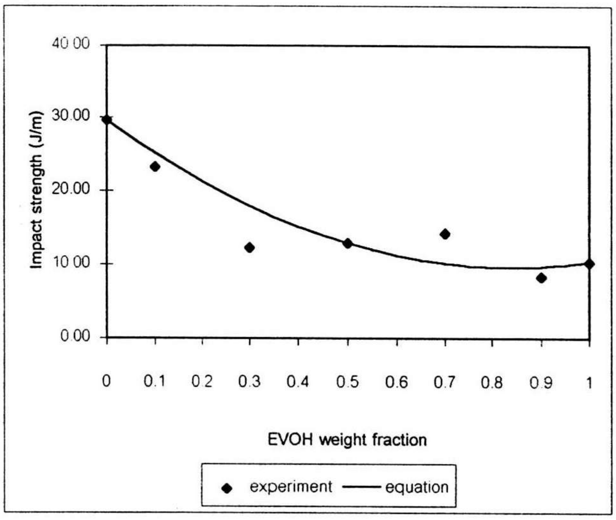


Fig. B.2.1 Impact strength of EVOH-71/ Nylon-6 blend [28]

PC/PAr blend

w.fraction	experiment	equation
0	260	260.0
0.15	110	213.4
0.2		208.4
0.3	223	214.4
0.4		241.6
0.5	290	290.0
0.6		359.6
0.7	438	450.4
0.85	676	626.4
0.9		695.6
1	850	850.0

Interaction parameter	-1060

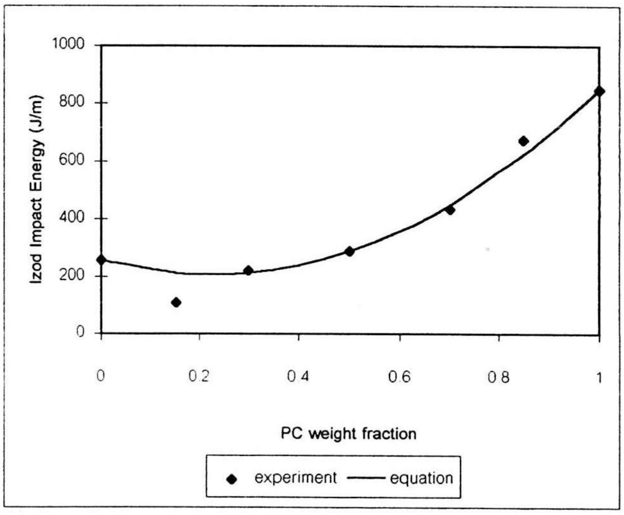


Fig. B.2.2 Izod impact energy of PC/PAr blend [73]

PEEK/Polyether sulfone blend

w.fraction	experiment	equation
0	90.0	90.0
0.15	86.0	87.0
0.2		86.1
0.3	83.3	84.5
0.4		83.2
0.5	82.2	82.2
0.6		81.4
0.7	83.3	80.9
0.85	84.4	80.7
0.9		80.7
1	81.0	81.0

Interaction parameter	-13.2

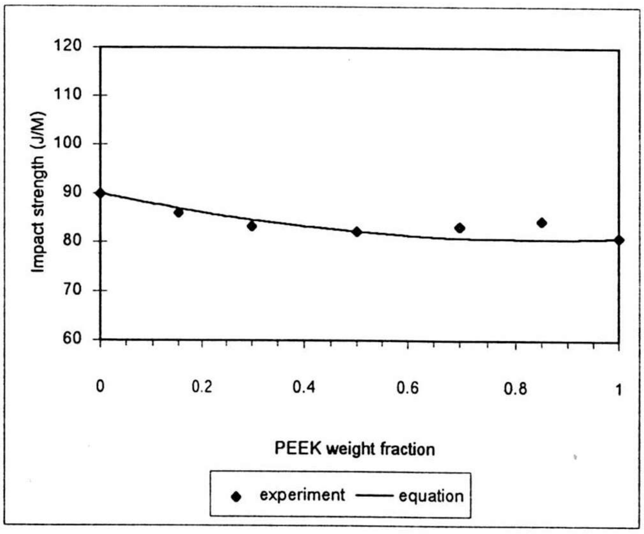


Fig. B.2.3 Impact strength of PEEK/Polyethersulfone blend [75]

PP/PA6 blend

w.fraction	experiment	equation
0	1.0	1.0
0.1		1.5
0.25	1.5	2.2
0.3		2.4
0.4	2.6	2.8
0.5	3.1	3.1
0.6	3.4	3.4
0.75	3.9	3.8
0.8		3.9
0.9		4.1
1	4.3	4.3

Interaction parameter	1.80

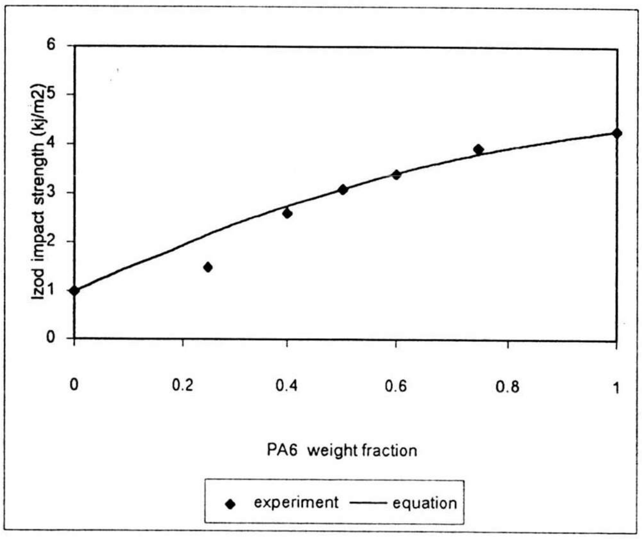


Fig. B.2.4 Impact strength of PP/Nylon-6 blend [76]

PP/PA6 blend

w.fraction	experiment	equation
0	1.8	1.80
0.1		2.78
0.2	2.8	3.57
0.3		4.16
0.4	4.5	4.55
0.5	4.8	4.75
0.6	5.0	4.75
0.7		4.56
0.8	4.4	4.17
0.9		3.58
1	2.8	2.80

Interaction parameter	9.80

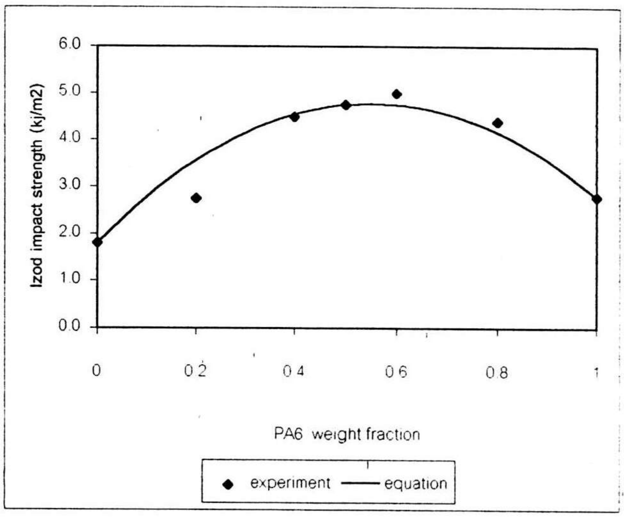


Fig. B.2.5 Impact strength of PP/Nylon-6 blend [55]

B.3 Stress of polymer blends

PEK-C/PSF blend

w.fraction	experiment	equation
0	88	88.0
0.1	92	90.7
0.2		93.2
0.3	97	95.4
0.4		97.3
0.5	99	99.0
0.6		100.4
0.7	101	101.6
0.8		102.5
0.9	103	103.1
1	104	103.5

Interaction parameter	13

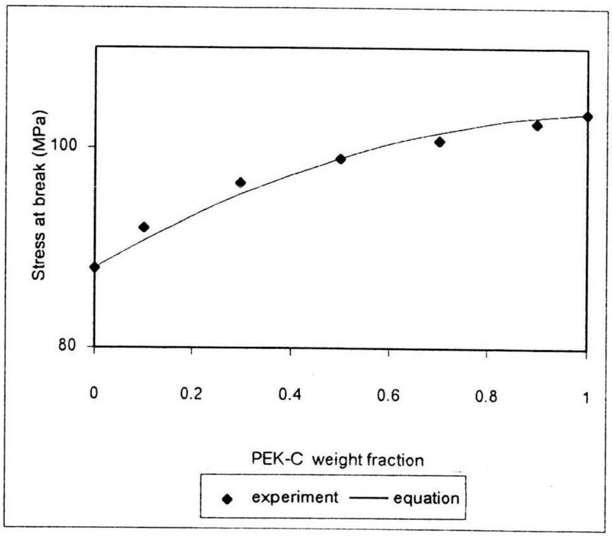


Fig. B.3.1 Stress at break of PEK-C/PSF blend [72]

PC/PAr blend

w.fraction	experiment	equation
100%	93.5	93.5
0.9		95.7
0.85	96.0	96.6
0.7	98.0	98.6
0.6		99.3
0.5	99.5	99.5
0.4		99.2
0.3	98.0	98.4
0.2		97.1
0.15	96.0	96.3
0	93.0	93.0

Interaction parameter	25

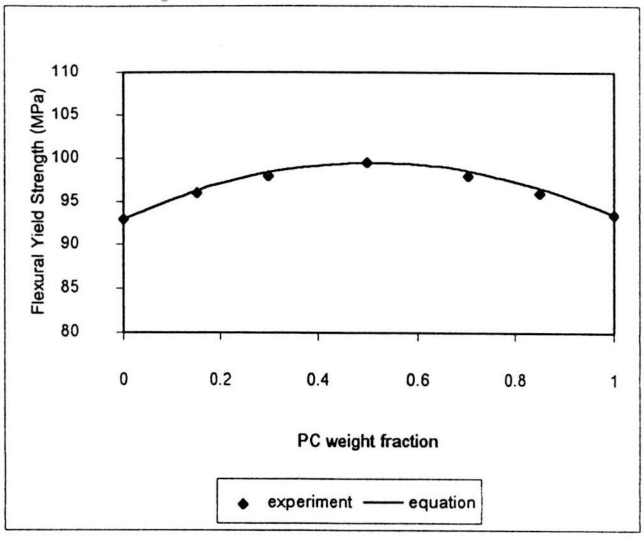


Fig. B.3.2 Flexural strength of PC/PAr blend [73]

PBT/PAr blend

w.fraction	experiment	equation
100%	68.0	68.0
0.9		67.7
0.8		66.9
0.7		65.7
0.6		64.1
0.5	62.0	62.0
0.4	57.0	59.5
0.3	53.5	56.5
0.2	51.0	53.1
0.1	48.5	49.3
0	45.0	45.0

Interaction parameter	22

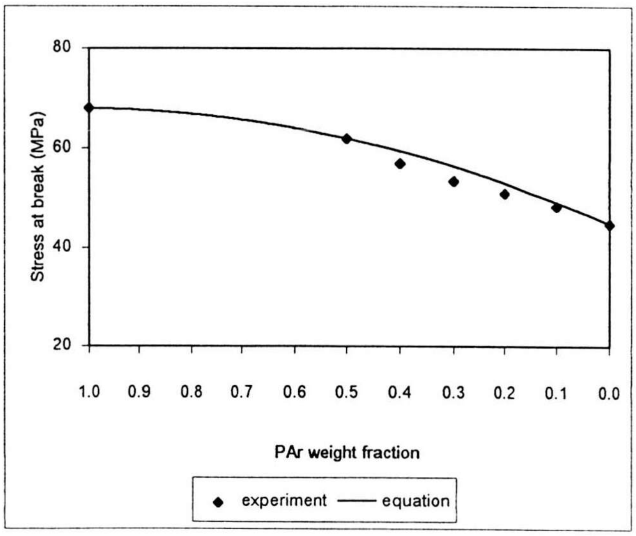


Fig. B.3.3 Strength at break of PBT/PAr blend [74]

PEEK/Polyether sulfone blend

w.fraction	experiment	equation
0	81.0	81.0
0.15	78.5	78.3
0.2		77.6
0.3	77.0	76.3
0.4		75.2
0.5	74.5	74.5
0.6		74.0
0.7	74.0	73.9
0.85	74.0	74.1
0.9		74.3
1	75.0	75.0

Interaction parameter	-14

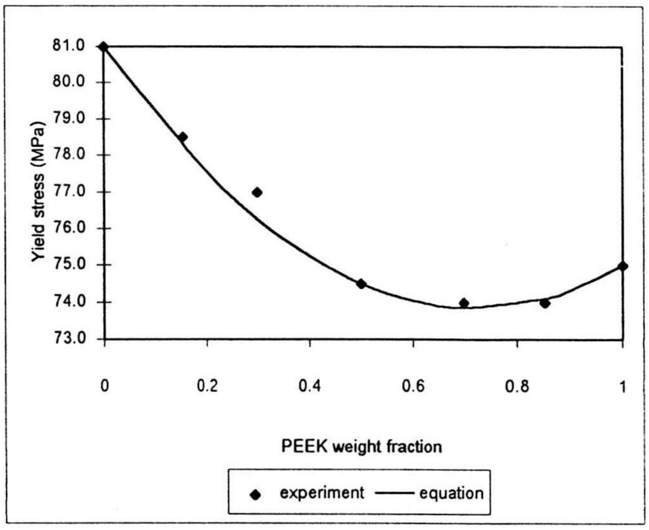


Fig. B.3.4 Yield stress of PEEK/Polyethersulfone blend [75]

PP/PA6 blend

w.fraction	experiment	equation
0	276	276
0.1		281.68
0.25	309	300.625
0.3		309.72
0.4	337	332.08
0.5	360	360
0.6	374	393.48
0.75	457	454.125
0.8		477.12
0.9		527.28
1	583	583

Interaction parameter	-278

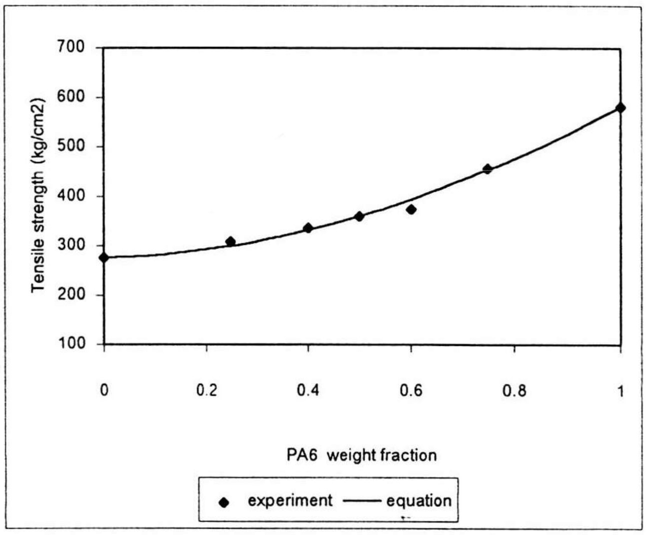


Fig. B.3.5 Tensile strength of PP/PA6 blend [76]

PMMA/Phenoxy blend

w.fraction	experiment	equation
0	645	645
0.1	625	634
0.2		623
0.3	605	613
0.4		604
0.5	595	595
0.6		587
0.7	585	579
0.8		572
0.9	565	566
1	560	560

Interaction parameter	-30

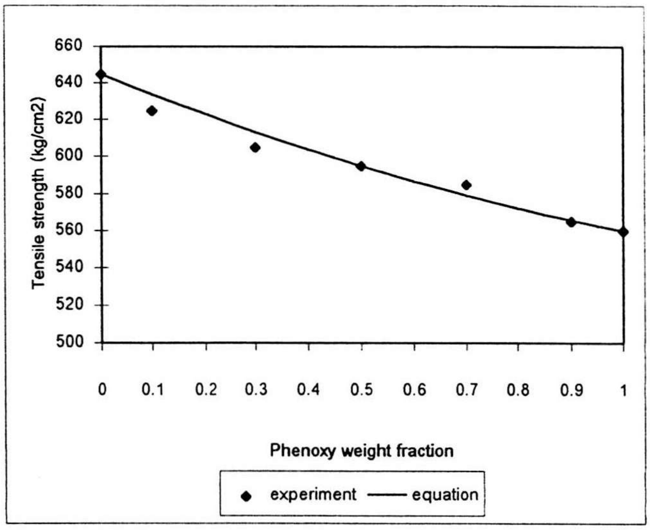


Fig. B.3.6 Tensile strength of PMMA/Phenoxy blend [37]

PHB/PVC blend

w.fraction	experiment	equation
0	225	225
0.1		248
0.2	285	273
0.3	280	300
0.4		329
0.5	360	360
0.6		393
0.7	440	428
0.8	470	465
0.9		504
1	545	545

Interaction parameter	-100

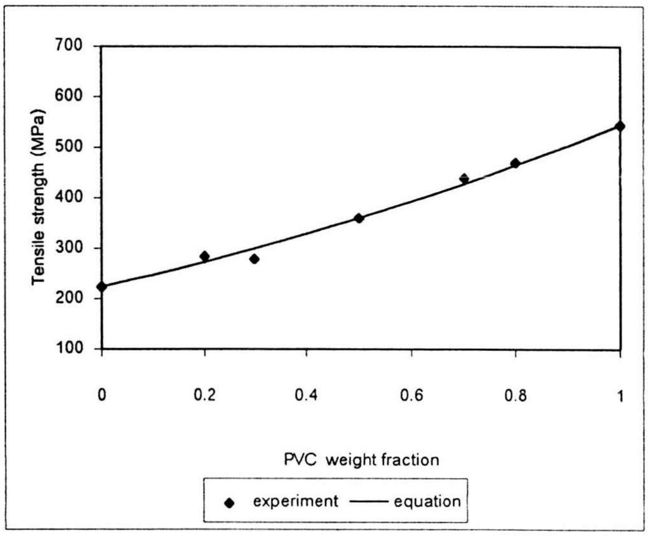


Fig. B.3.7 Tensile strength of PHB/PVC blend [38]

PA6/PP blend

w.fraction	experiment	equation
0	70	70.0
0.1	56	60.0
0.2	44	51.4
0.3	40	44.0
0.4		37.8
0.5	33	33.0
0.6		29.4
0.7	30	27.2
0.8	30	26.2
0.9	29	26.4
1	28	28.0

Interaction parameter	-64

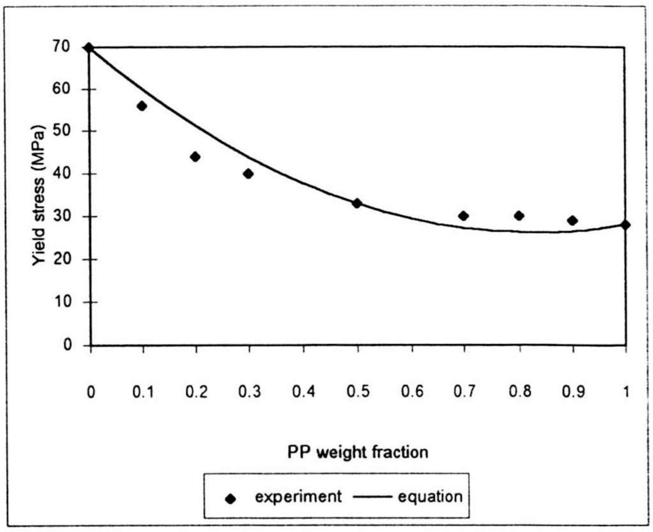


Fig. B.3.8 Tensile strength of PA6/PP blend [39]

PP/NBR blend

w.fraction	experiment	equation
0	35.0	35.00
0.1		28.47
0.2		22.63
0.3	18.3	17.47
0.4		12.99
0.5	9.2	9.20
0.6		6.09
0.7	3.5	3.66
0.8		1.92
0.9		0.85
1	0.5	0.48

Interaction parameter	-34.15

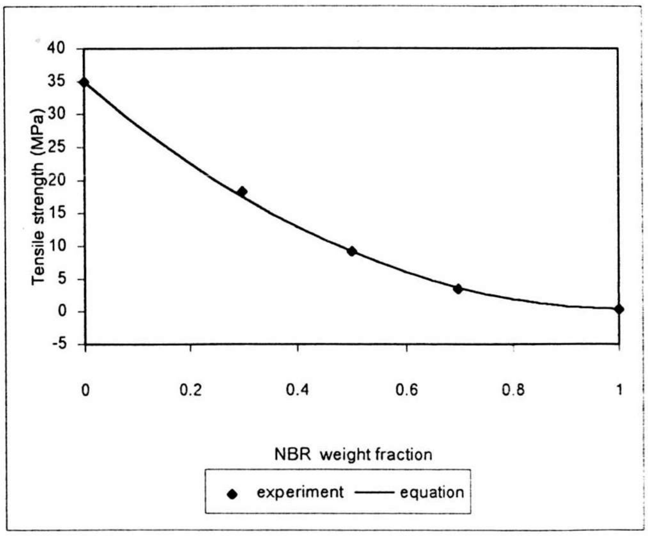


Fig. B.3.9 Tensile strength of PP/NBR blend [40]

PES/PMIA blend

w.fraction	experiment	equation
0	85	85.0
0.1		85.3
0.2	83	85.9
0.3		86.9
0.4	92	88.3
0.5	90	90.0
0.6	97	92.1
0.7	100	94.5
0.8		97.3
0.9		100.5
1	104	104.0

Interaction parameter	-18

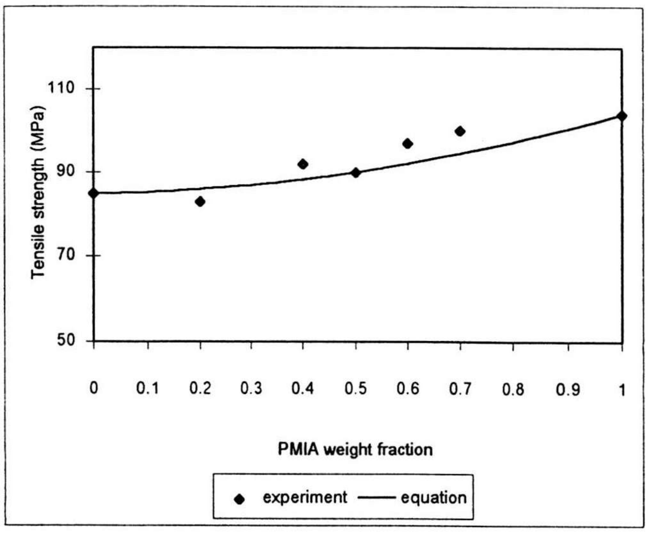


Fig. B.3.10 Tensile strength of PES/PMIA blend [41]

PPS/PSF blend

w.fraction	experiment	equation
0	65	65.0
0.1		62.3
0.2		60.1
0.25	50	59.1
0.4		56.9
0.5	56	56.0
0.6		55.5
0.75	52	55.6
0.8		55.9
0.9		56.7
1	58	58.0

Interaction parameter	-22

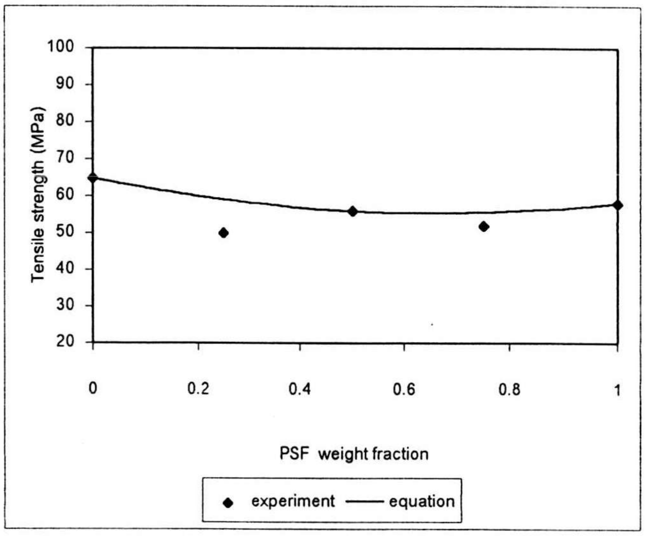


Fig. B.3.11 Tensile strength of PPS/PSF blend [42]

PP/LCP(Vectra) blend

w.fraction	experiment	equation
0	234.0	234.0
0.1		182.4
0.2	74.4	137.8
0.3		100.2
0.4		69.5
0.5	45.7	45.7
0.6		28.9
0.7	36.6	19.1
0.8	31.1	16.2
0.9		20.2
1	31.2	31.2

Interaction parameter	-347.64

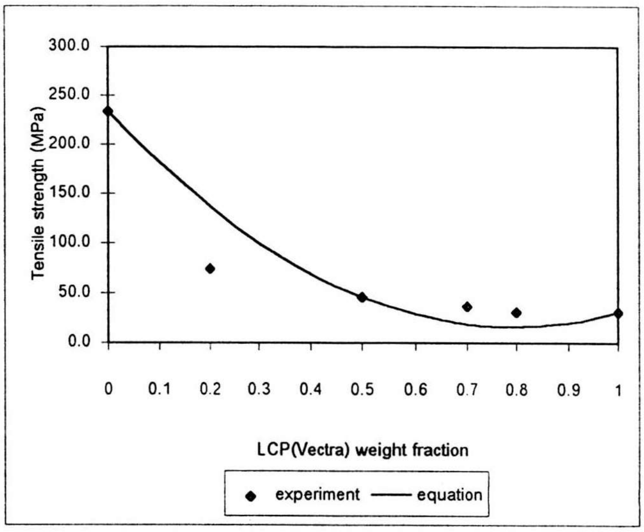


Fig. B.3.12 Tensile strength of PP/LCP(Vectra) blend [43]

SBS/MS blend

w.fraction	experiment	equation
0	23	23
0.1		26
0.25	29	31
0.3	32	33
0.4		36
0.5	40	40
0.6		44
0.75	51	49
0.8	54	51
0.9		55
1	59	59

Interaction parameter	-4

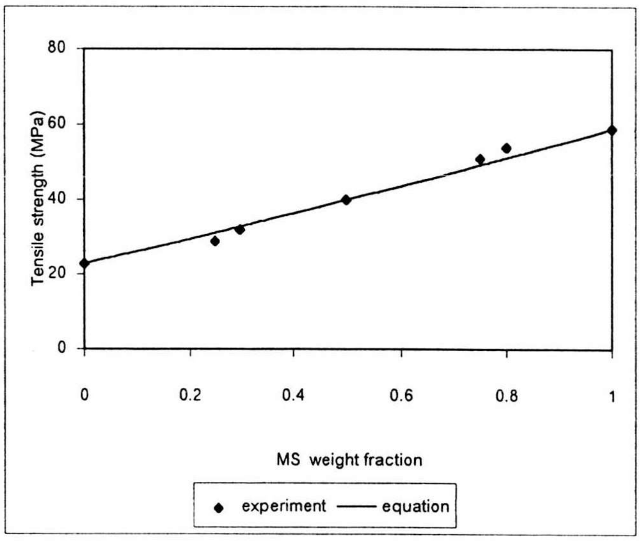


Fig. B.3.13 Tensile strength of SBS/MS blend [45]

LLDPE/PP blend

w.fraction	experiment	equation
0	8.5	8.5
0.1	8.0	8.5
0.2		8.8
0.3	7.5	9.6
0.4		10.9
0.5	12.5	12.5
0.6		14.6
0.7	18.5	17.0
0.8		19.9
0.9	26.0	23.3
1	27.0	27.0

Interaction parameter	-21

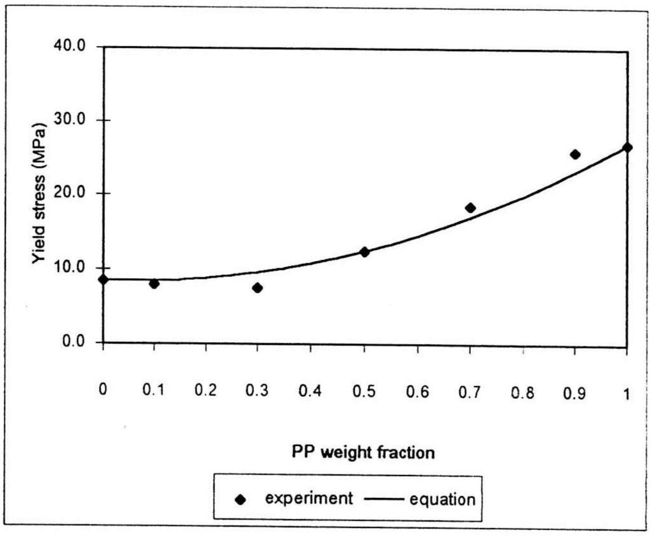


Fig. B.3.14 Yield stress of LLDPE/PP blend [46]

DGEBA/EME blend

w.fraction	experiment	equation
0	3	3.0
0.1		2.8
0.25	5	5.1
0.3		6.6
0.4		10.6
0.5	16	16.0
0.6		22.8
0.65	37	26.7
0.8		40.6
0.9	50	51.6
1	64	64.0

Interaction parameter	-70

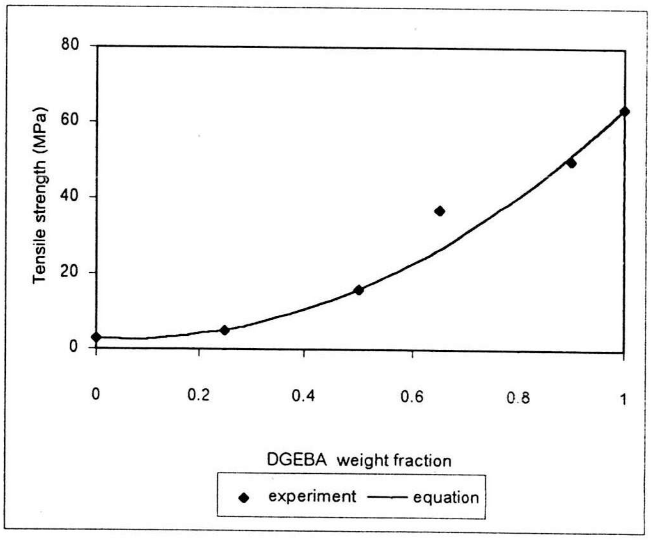


Fig. B.3.15 Tensile strength of DGEBA/EME blend [47]

PEI/PET blend

w.fraction	experiment	equation
0	52	52
0.1		59
0.25	63	69
0.3		72
0.4		78
0.5	83	83
0.6		88
0.7		93
0.75	103	95
0.9		101
1	104	104

Interaction parameter	20

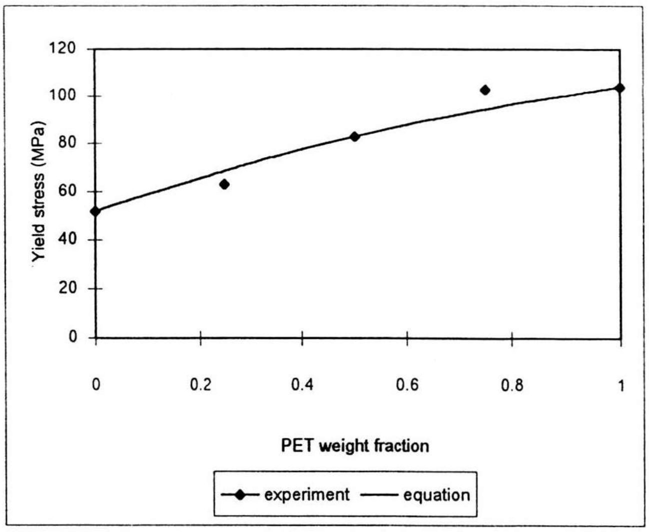


Fig. B.3.16 Yield stress of PEI/PET blend [48]

LDPE/HDPE blend

w.fraction	experiment	equation
0	12.5	12.5
0.1	13.0	12.7
0.2	13.3	13.3
0.35	17.2	14.9
0.4		15.7
0.5	17.5	17.5
0.65	19.2	21.0
0.7		22.4
0.8	21.7	25.4
0.9	21.9	28.8
1	32.7	32.7

Interaction parameter	-20.4

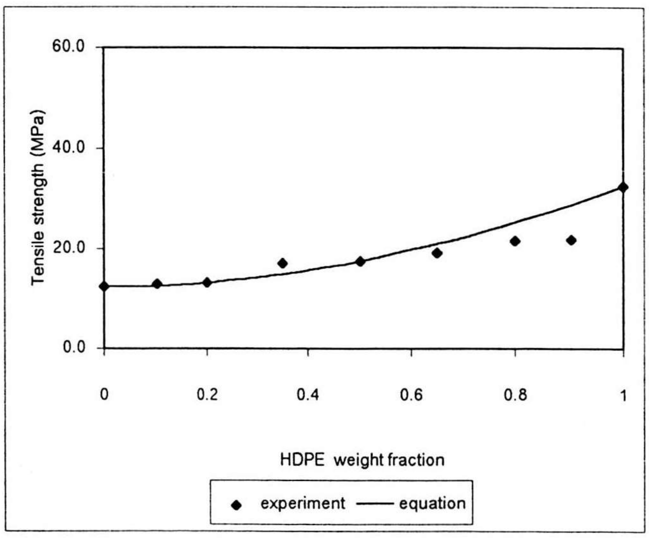


Fig. B.3.17 Tensile strength of LDPE/HDPE blend [49]

LLDPE/PP blend

w.fraction	experiment	equation
0	57	57
0.1	56	53.6
0.2	52	50
0.3		46.2
0.4		42.2
0.5	38	38
0.6		33.6
0.7		29
0.8	27	24.2
0.9	22	19.2
1	14	14

Interaction parameter	10

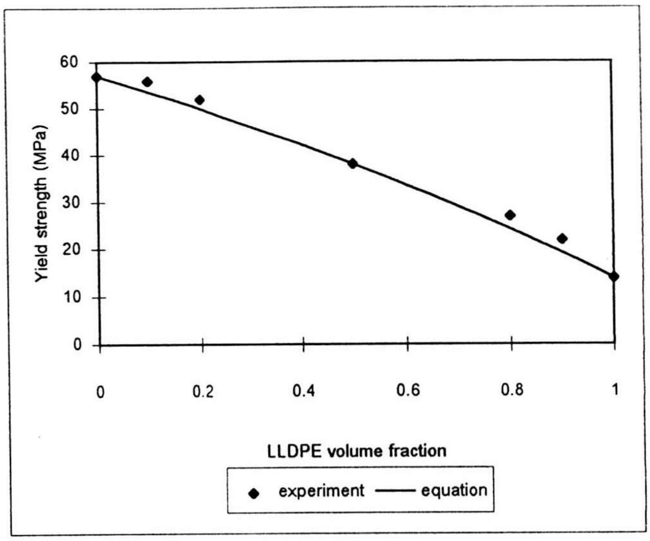


Fig. B.3.18 Yield strength of LLDPE/PP blend [30]

LLDPE/PP blend

w.fraction	experiment	equation
0	16.2	16.2
0.1	17.8	17.6
0.2	19.2	18.9
0.3		20.2
0.4	21.4	21.3
0.5	22.4	22.4
0.6	23.4	23.4
0.7		24.3
0.8	25.1	25.2
0.9	26.0	25.9
1	26.6	26.6

Interaction parameter	4

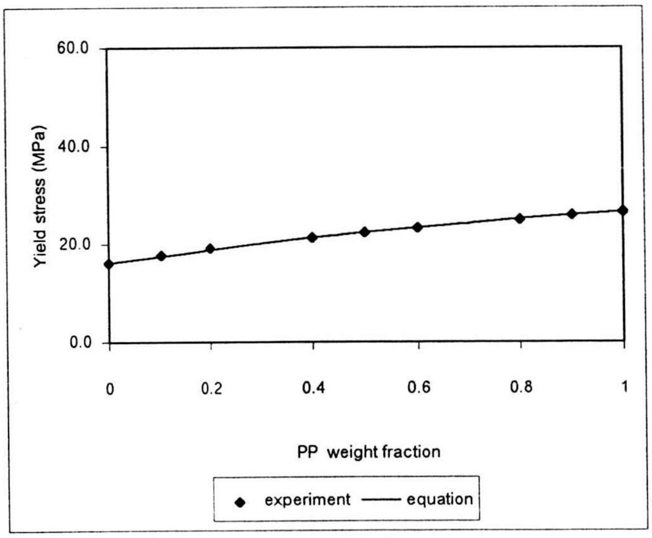


Fig. B.3.19 Tensile strength of LLDPE/PP blend [51]

PC/ABS blend

w.fraction	experiment	equation
0	7.8	7.8
0.1	5.3	6.8
0.2		6.0
0.3	5.0	5.3
0.4		4.7
0.5	4.2	4.2
0.6		3.8
0.7	3.8	3.6
0.8		3.4
0.9	3.6	3.4
1	3.5	3.5

Interaction parameter	-5.8

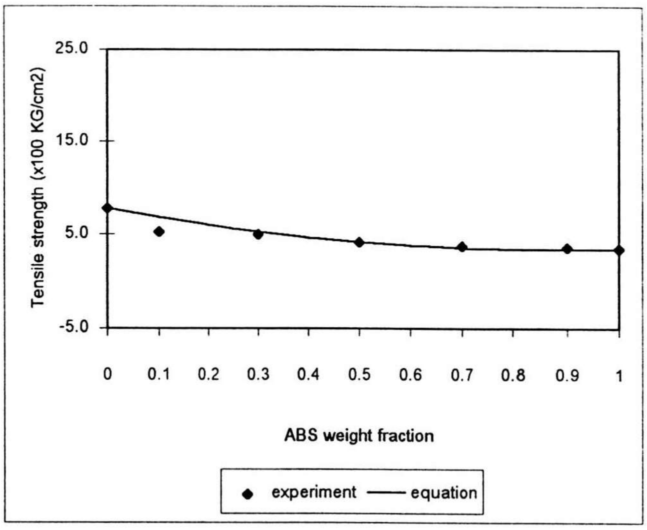


Fig. B.3.20 Tensile strength of PC/ABS blend [53]

PC/Copolyester blend

w.fraction	experiment	equation
0	14.5	14.5
0.1		14.1
0.2	14.3	13.7
0.3		13.3
0.4	13.5	12.8
0.5	12.4	12.4
0.6	12.2	11.9
0.7		11.5
0.8	11.3	11.0
0.9		10.5
1	10.0	10.0

Interaction parameter	0.6

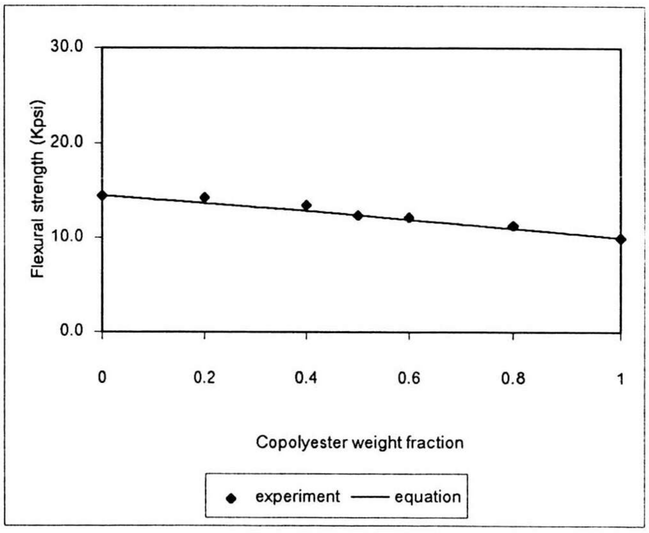


Fig. B.3.21 Flexural strength of PC/Copolyester blend [54]

PC/PMMA blend

w.fraction	experiment	equation
0	7.80	7.80
0.1	7.50	7.81
0.2		7.78
0.3	7.65	7.71
0.4		7.62
0.5	7.48	7.48
0.6		7.31
0.7	7.17	7.10
0.8		6.86
0.9	6.62	6.58
1	6.27	6.27

Interaction parameter	1.78

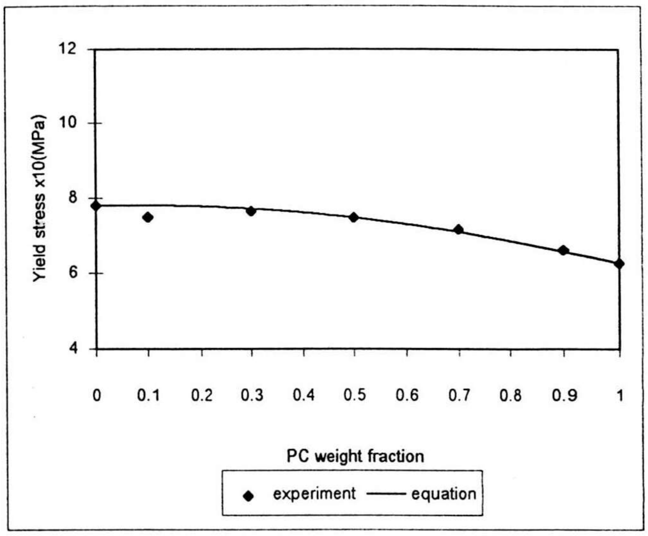


Fig. B.3.22 Yield stress of PC/PMMA blend [56]

PVC/PI blend

w.fraction	experiment	equation
0	47	47.0
0.1		48.2
0.2	50	49.2
0.3		49.8
0.4	51	50.0
0.5	50	50.0
0.6	49	49.6
0.7		49.0
0.8	47	48.0
0.9		46.6
1	45	45.0

Interaction parameter	16

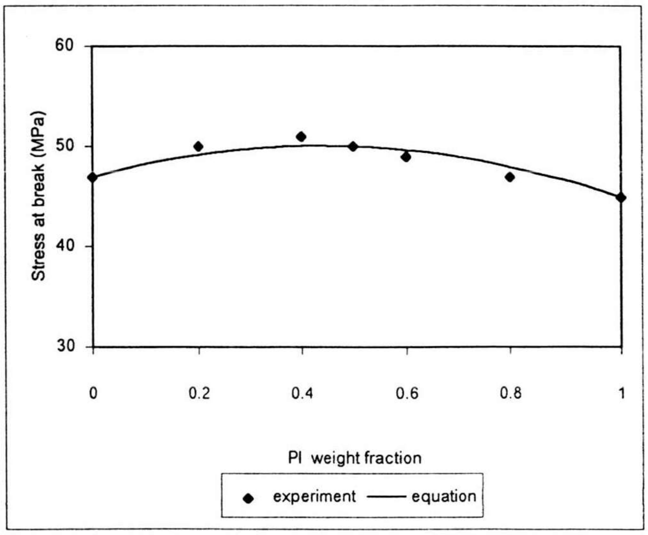


Fig. B.3.23 Stress at break of PVC/PI blend [57]

PP/PA1010 blend

w.fraction	experiment	equation
0	28.0	28.0
0.15	28.0	26.6
0.25	28.0	26.9
0.35	28.8	28.1
0.45	29.4	30.3
0.5	31.7	31.7
0.55	33.5	33.4
0.65	36.0	37.4
0.75	40.0	42.4
0.85	43.5	48.3
0.95	49.0	55.2
1	59.0	59.0
Interaction parameter		-47.2

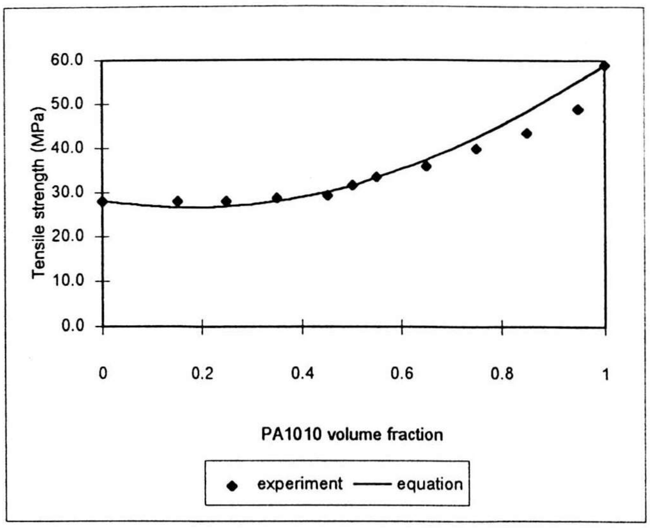


Fig. B.3.24 Tensile strength of PP/PA1010 blend [58]

NR/EVA blend

w.fraction	experiment	equation
0	0.20	0.20
0.1		-0.21
0.2	0.63	-0.05
0.3		0.66
0.4	1.67	1.92
0.5	3.75	3.75
0.6	6.25	6.13
0.7		9.08
0.8	13.75	12.58
0.9		16.63
1	21.25	21.25

Interaction parameter	-27.9

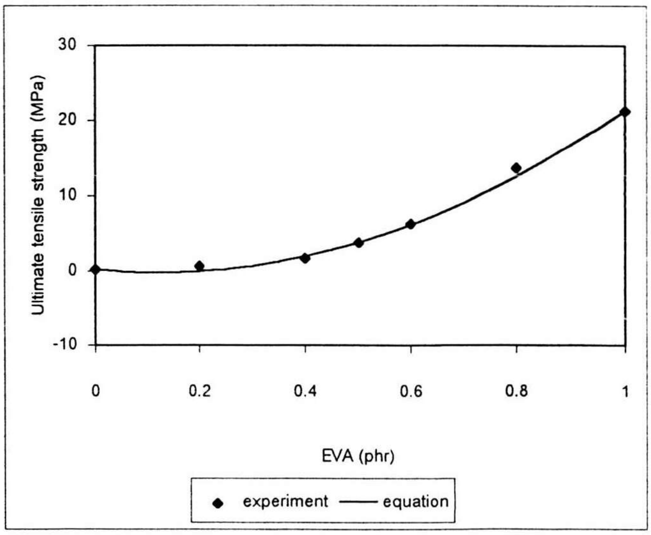


Fig. B.3.25 Ultimate tensile strength of NR/EVA blend [59]

LLDPE/PP blend

w.fraction	experiment	equation
0	18.0	18.0
0.1	17.5	19.2
0.25	19.5	21.1
0.3		21.8
0.4		23.4
0.5	25.0	25.0
0.6		26.8
0.75	28.0	29.6
0.8		30.6
0.9		32.8
1	35.0	35.0

Interaction parameter	-6

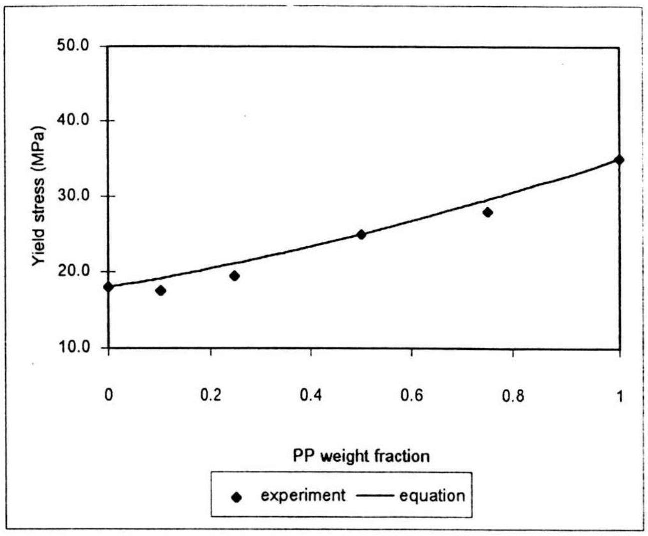


Fig. B.3.26 Yield stress of HDPE/PP blend [60]

PEI/PAr blend

w.fraction	experiment	equation
0	107	107.0
0.1	102	100.9
0.2	95	95.1
0.3	90	89.7
0.4	87	84.7
0.5	80	80.0
0.6	82	75.7
0.7	75	71.7
0.8	69	68.1
0.9	67	64.9
1	62	62.0

Interaction parameter	-18

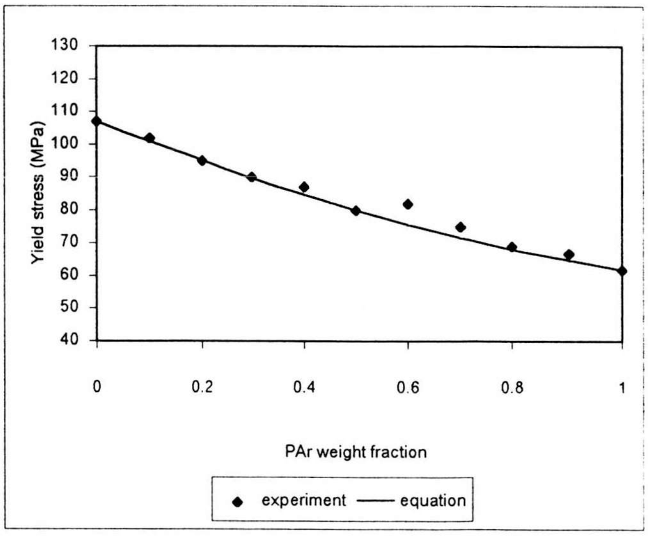


Fig. B.3.27 Yield stress of PEI/PAr blend [61] m-EPDM/Zn-EMA blend

w.fraction	experiment	equation
0	11.6	11.6
0.1		12.8
0.2		13.7
0.3		14.0
0.4		13.9
0.5	13.4	13.4
0.6	12.1	12.4
0.7	11.1	11.0
0.8	9.7	9.2
0.9	8.6	6.8
1	4.1	4.1

Interaction parameter	22.2

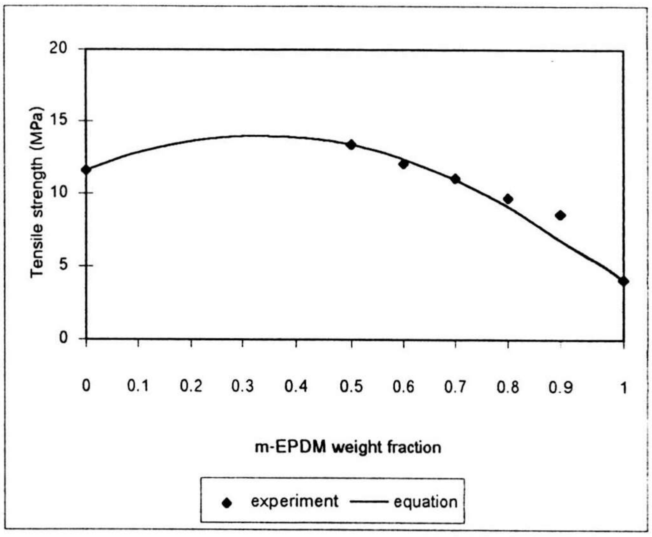


Fig. B.3.28 Tensile strength m-EPDM/Zn-EME blend [62]

PP/PVC blend

w.fraction	experiment	equation
0	33.4	33.4
0.1	23.8	25.7
0.2	20.6	19.9
0.3	18.0	16.1
0.4	14.7	14.3
0.5	14.4	14.4
0.6	15.6	16.5
0.7	16.9	20.5
0.8	28.7	26.5
0.9	37.8	34.4
1	44.3	44.3

Interaction parameter	-97.8

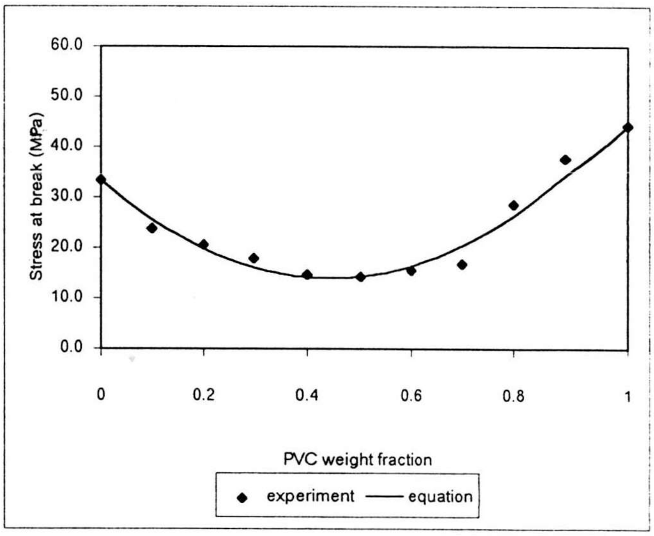


Fig. B.3.29 Stress at break PP/PVC blend [63]

PP/PC blend

w.fraction	experiment	equation
0	28.7	28.7
0.1	25.6	22.8
0.25	16.0	16.9
0.3		15.6
0.4		14.3
0.5	14.4	14.4
0.6		16.0
0.75	29.0	21.3
0.8		23.8
0.9		29.9
1	37.5	37.5

Interaction parameter	-74.8

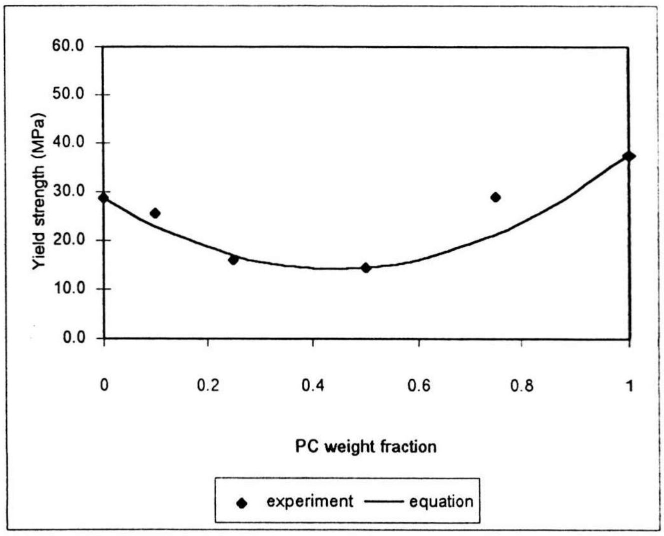


Fig. B.3.30 Yield strength of PP/PC blend [63]

LDPE/ABS blend

w.fraction	experiment	equation
0	23	23.0
0.1	19	19.5
0.2	19	16.6
0.3		14.1
0.4	12	12.0
0.5	11	10.5
0.6	9	9.4
0.7		8.9
0.8	7	8.8
0.9		9.1
1	10	10.0

Interaction parameter	-24

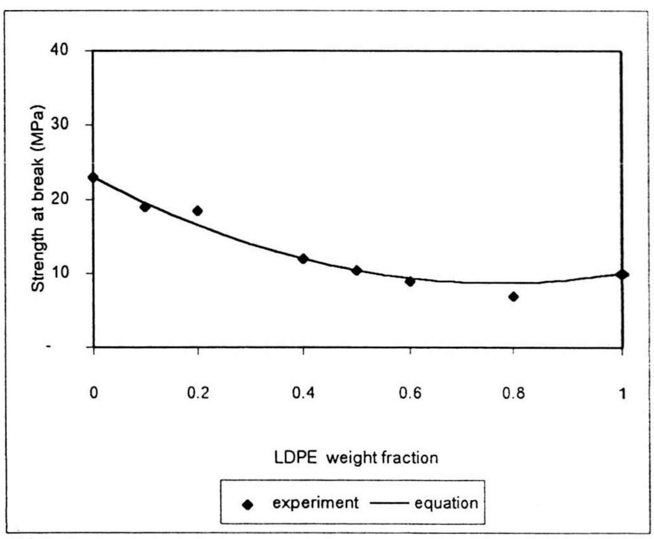


Fig. B.3.31 Strength at break of LDPE/ABS blend [64]

PS/HDPE blend

w.fraction	experiment	equation
0	3250	3250
0.1		3450
0.25	3500	3843.75
0.3		4000
0.4		4350
0.5	4750	4750
0.6		5200
0.75	5380	5968.75
0.8		6250
0.9		6850
1	7500	7500

Interaction parameter	-2500

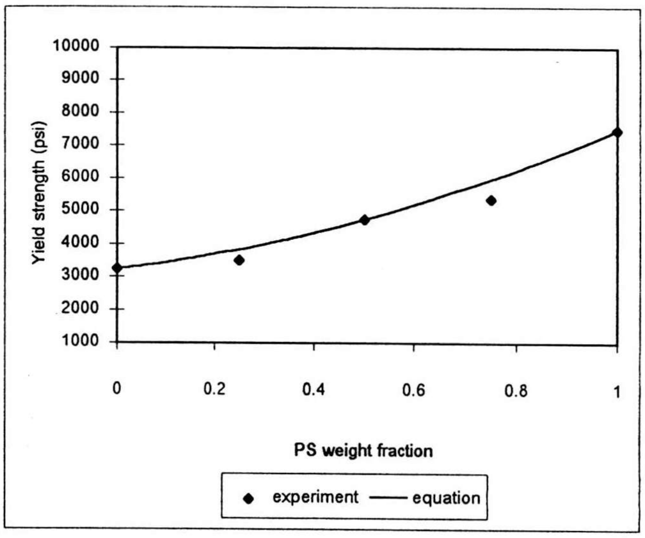


Fig. B.3.32 Yield strength of PS/HDPE blend [65]

ABS/PC blend

w.fraction	experiment	equation
0	5875	5875
0.15	6218	6318
0.25	6281	6595
0.3		6727
0.4	6812	6981
0.5	7220	7220
0.6	7375	7444
0.75	7593	7751
0.85	7781	7937
0.9		8025
1	8188	8188

Interaction parameter	754

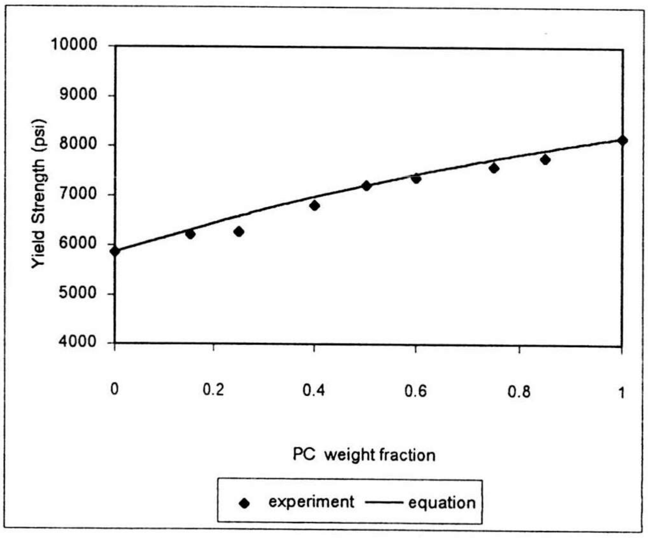


Fig. B.3.33 Yield strength of ABS/PC blend [66]

HIPS/ABS blend

w.fraction	experiment	equation
0	7265	7265
0.1		6830
0.25	5900	6418
0.3		6031
0.4		5669
0.5	5330	5330
0.6		5016
0.75	4650	4725
0.8		4459
0.9		4218
1	4000	4000

Interaction parameter	-1210

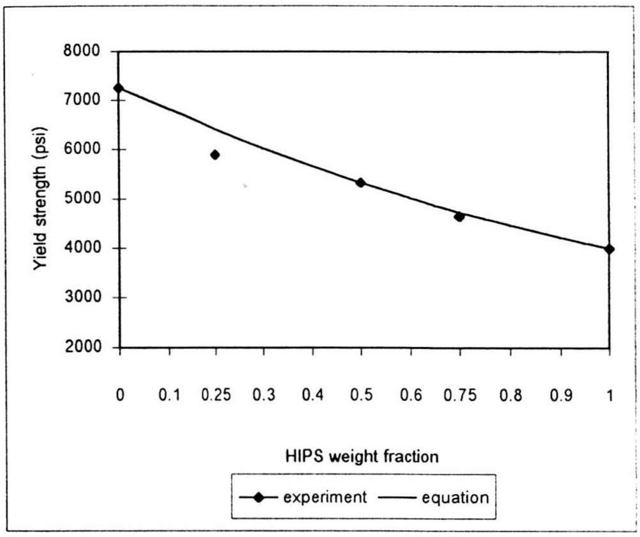


Fig. B.3.34 Yield strength of HIPS/ABS blend [67]

ABS/PC blend

w.fraction	experiment	equation
0	10800	10800
0.1		10412
0.25	9700	9725
0.35	9300	9197
0.4		8912
0.5	8300	8300
0.6	7900	7632
0.75	6200	6525
0.8	5600	6128
0.9	4800	5292
1	4400	4400

Interaction parameter	2800

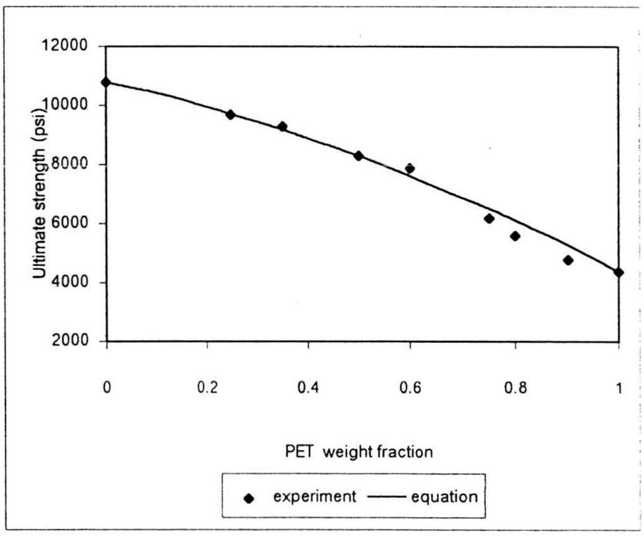


Fig. B.3.35 Ultimate strength of PC/PET blend [69]

HDPE/PP blend

w.fraction	experiment	equation
0	4800	4800
0.1		4736
0.25	4600	4664
0.3		4584
0.4		4496
0.5	4400	4400
0.6		4296
0.7		4184
0.75	4000	4064
0.9		3936
1	3800	3800

Interaction parameter	400

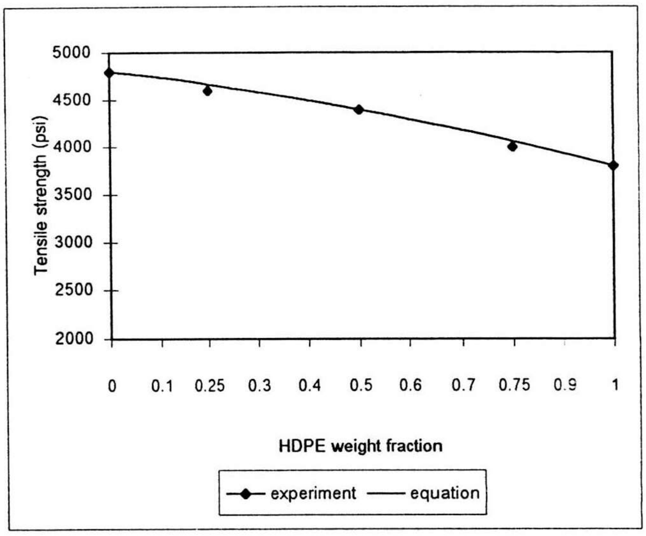


Fig. B.3.36 Tensile strength of HDPE/PP blend [70]

LPE/PP blend

w.fraction	experiment	equation
0	32.0	32.0
0.1	31.8	31.7
0.2	31.3	31.3
0.25	31.2	31.1
0.4		30.4
0.5	29.8	29.8
0.6		29.1
0.75	27.5	28.0
0.8		27.6
0.9		26.7
1	25.8	25.8

Interaction parameter	3.6

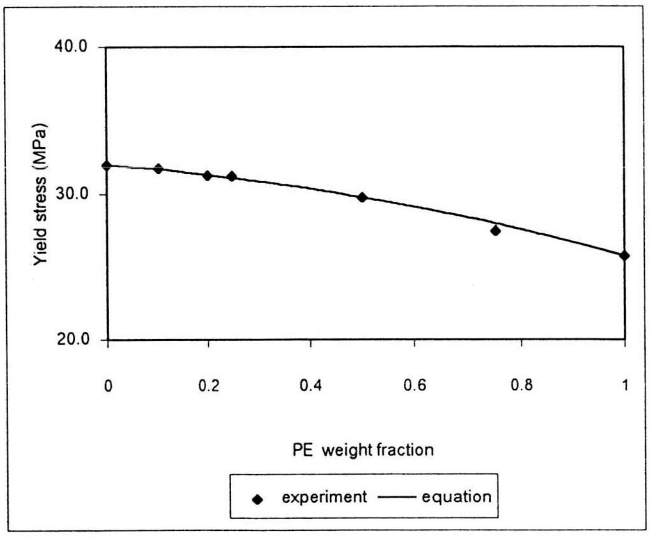


Fig. B.3.37 Yield stress of LPE/PP blend [71]

LPE/UHMWLPE

w.fraction	experiment	equation
0	160	160
0.1	276	262
0.2		342
0.3	338	401
0.4		439
0.5	455	455
0.6		450
0.7	448	423
0.8		375
0.9		305
1	214	214

Interaction parameter	1072.00

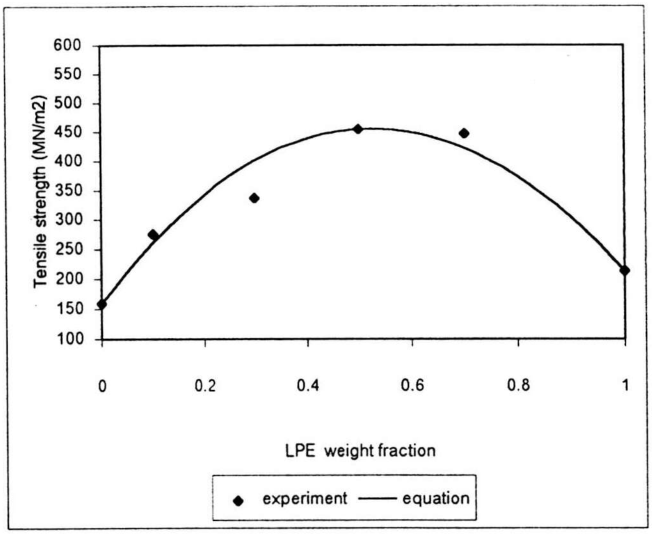


Fig. B.3.38 Tensile strength of LPE/UHMWLPE blend [27]

B.4 Elongation of polymer blends

PC/PA blend

w.fraction	experiment	equation
0	5.15	5.15
0.05	4.95	5.38
0.25	6.05	6.17
0.3		6.33
0.4	6.25	6.59
0.5	6.80	6.80
0.6	6.57	6.94
0.75	7.40	7.04
0.8		7.05
0.9	7.00	7.00
1	6.90	6.90

Interaction parameter	3.10

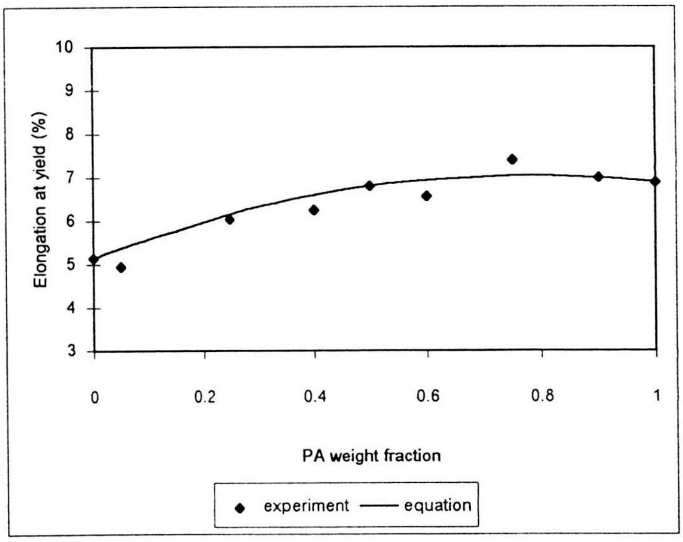


Fig. B.4.1 Elongation at yield of PC/PA blend [26]

PEEK/PES blend

w.fraction	experiment	equation
0	77	77.0
0.15	80	77.8
0.2		77.7
0.3	75	77.1
0.4		75.9
0.5	74	74.0
0.6		71.5
0.7	67	68.3
0.85	62	62.4
0.9		60.1
1	55	55.0

Interaction parameter	32.00

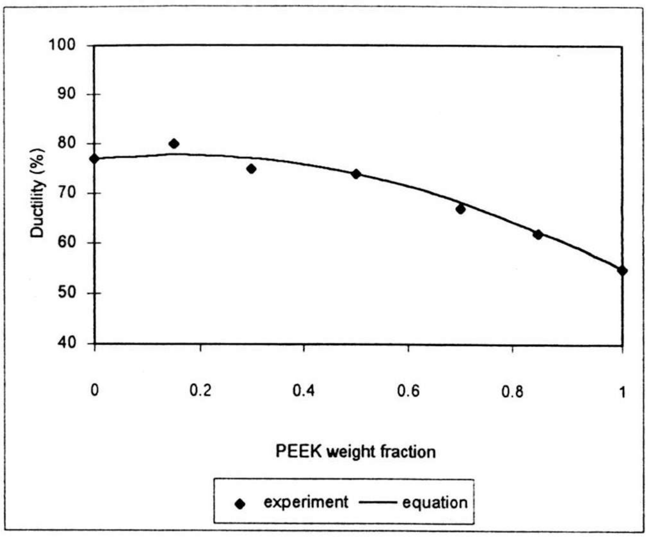


Fig. B.4.2 Ductility of PEEK/PES blend [75]

PHB/PVC blend

w.fraction	experiment	equation
0	10.80	10.80
0.1		9.98
0.2	9.70	9.28
0.3	9.63	8.70
0.4		8.24
0.5	7.90	7.90
0.6		7.68
0.7	8.00	7.58
0.8	8.37	7.60
0.9		7.74
1	8.00	8.00

Interaction parameter	-6.00

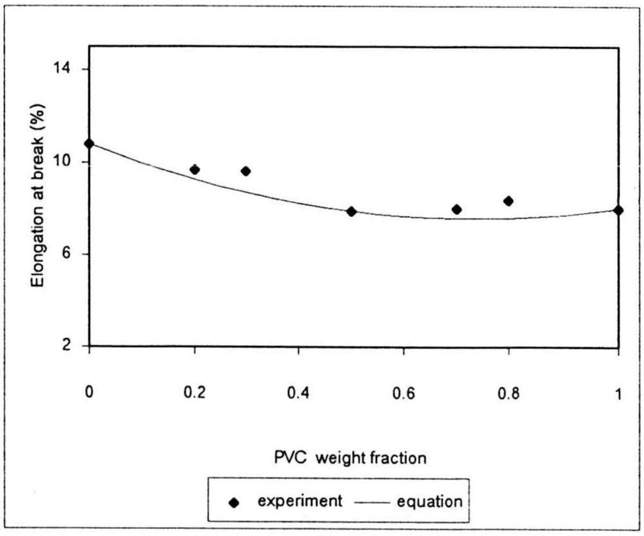


Fig. B.4.3 Elongation at break of PHB/PVC blend [38]

LLDPE/PP blend

w.fraction	experiment	equation
0	1350	1350
0.1	625	985
0.2		685
0.3	475	450
0.4		280
0.5	175	175
0.6		135
0.7	225	160
0.8		250
0.9	500	405
1	625	625

Interaction parameter	-3250.00

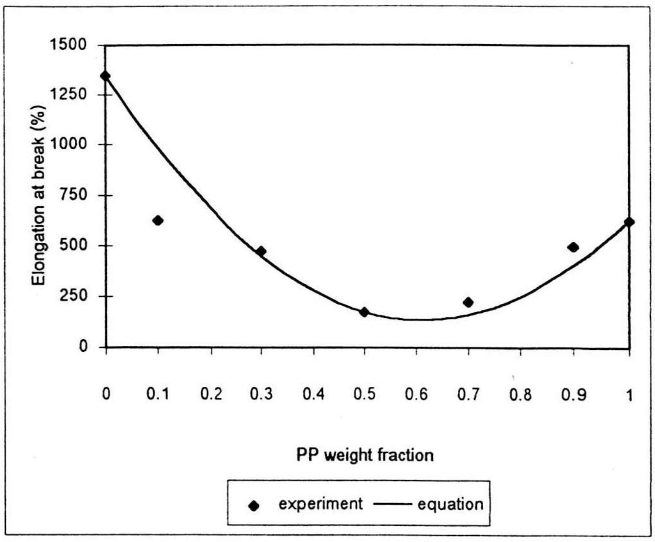


Fig. B.4.4 Elongation at break of LLDPE/PP blend [46]

DGEBA/EME blend

w.fraction	experiment	equation
0	36	36.0
0.1		26.4
0.25	10	14.8
0.3		11.6
0.4		6.6
0.5	3	3.0
0.6		1.0
0.65	4	0.5
0.75		0.8
0.9	5	4.0
1	8	8.0

Interaction parameter	-76.00

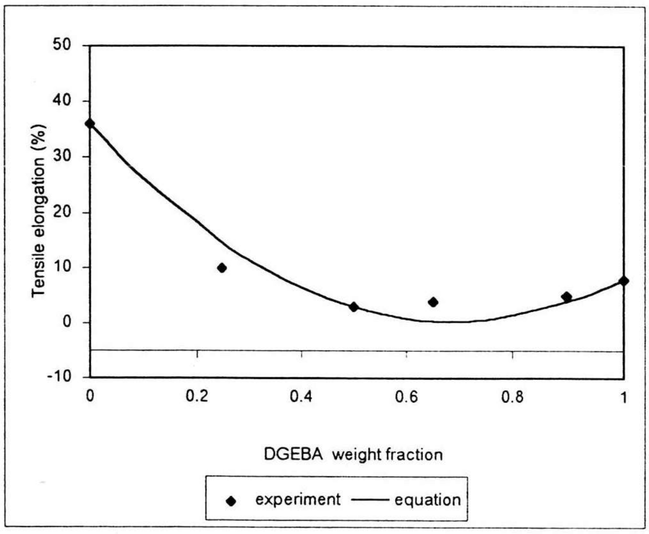


Fig. B.4.5 Tensile elongation of DGEBA/EME blend [47]

PEI/PET blend

w.fraction	experiment	equation
0	50	50.0
0.1		24.6
0.2		10.4
0.25	18	7.5
0.4	48	15.6
0.5	35	35.0
0.6	10	65.6
0.75	90	132.5
0.8		160.4
0.9		224.6
1	300	300.0

Interaction parameter	-560.00

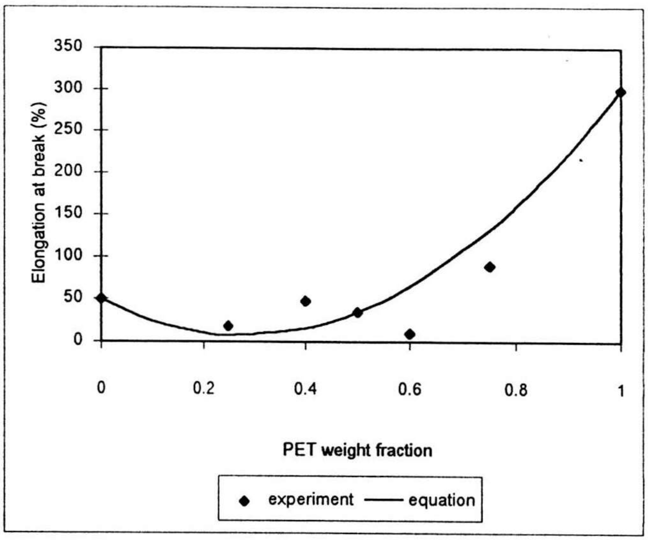


Fig. B.4.6 Ductility of PEI/PET blend [48]

PC/ABS blend

w.fraction	experiment	equation
0	49.0	49.0
0.1	47.5	36.4
0.2		26.0
0.3	8.8	17.6
0.4		11.4
0.5	7.2	7.2
0.6		5.2
0.7	10.0	5.2
0.8		7.4
0.9	14.0	11.6
1	18.0	18.0

Interaction parameter	-105.20

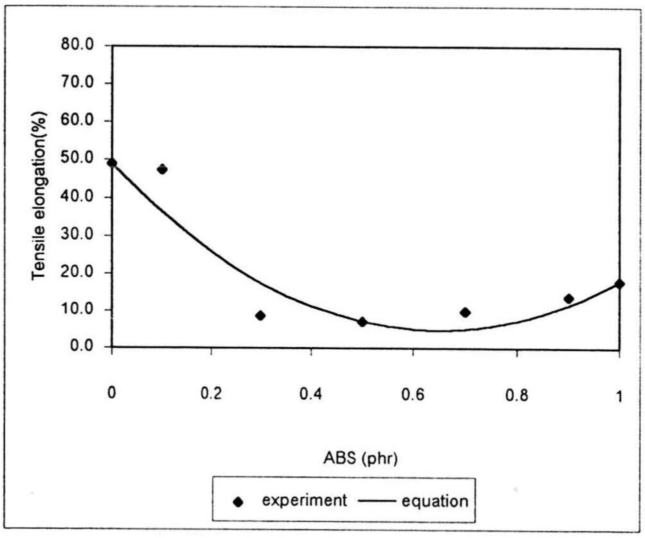


Fig. B.4.7 Elongation at break of PC/ABS blend [53]

NR/EVA blend

w.fraction	experiment	equation
0	350	350.0
0.1		433.9
0.2	600	505.6
0.3		565.1
0.4	650	612.4
0.5	647.5	647.5
0.6	645	670.4
0.7		681.1
0.8	645	679.6
0.9		665.9
1	640	640.0

Interaction parameter	610.00

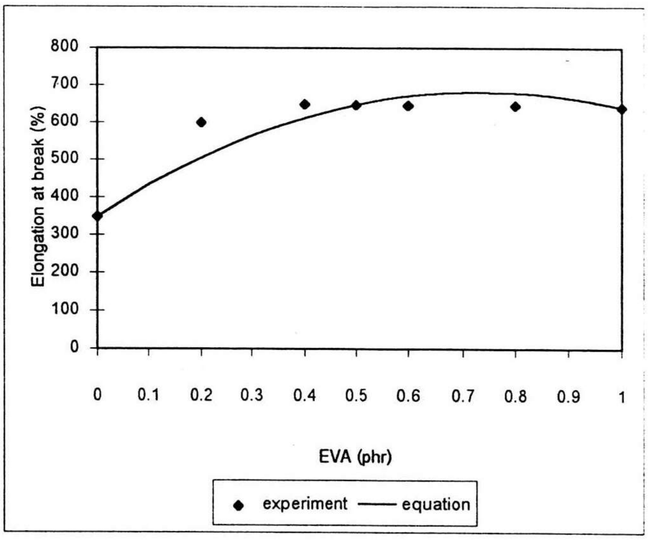


Fig. B.4.8 Elongation at break of NR/EVA blend [59]

LLDPE/PP blend

w.fraction	experiment	equation
0	1.10	1.10
0.1	0.97	0.87
0.25	0.63	0.58
0.3		0.49
0.4		0.36
0.5	0.25	0.25
0.6		0.18
0.75	0.21	0.13
0.8		0.12
0.9	0.21	0.15
1	0.20	0.20

Interaction parameter	-1.60

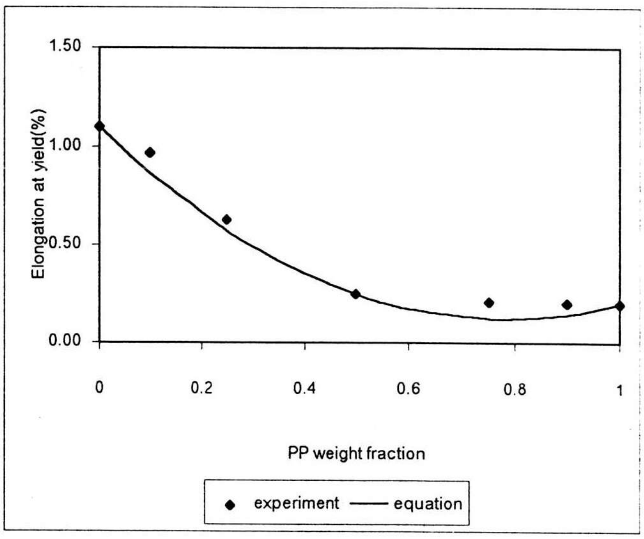


Fig. B.4.9 Elongation at yield of LLDPE/PP blend [60]

ABS/PC blend

w.fraction	experiment	equation
0	53	53
0.1	21	35.96
0.25	9.2	23.64
0.3		16.04
0.4	9.35	13.16
0.5	15	15
0.6	21	21.56
0.75	38.7	32.84
0.8	50	48.84
0.9	79	69.56
1	95	95

Interaction parameter	-236.00

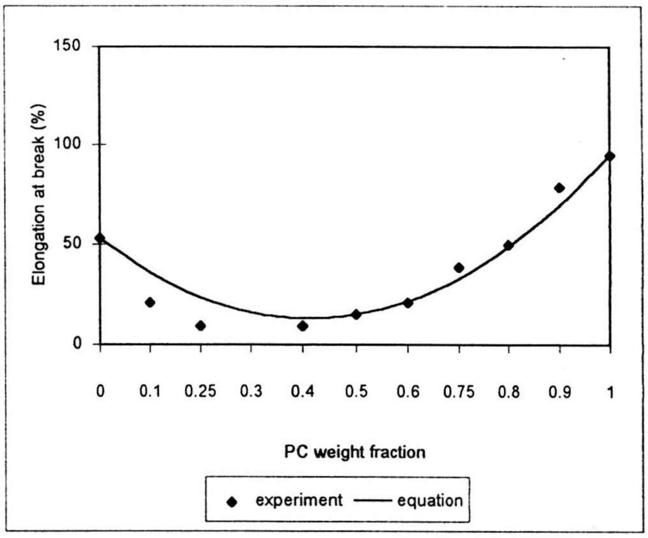


Fig. B.4.10 Elongation at break of ABS/PC blend [66]

HIPS/ABS blend

w.fraction	experiment	equation
0	20.0	20.00
0.1		24.84
0.25	33.5	31.88
0.3		34.16
0.4		38.64
0.5	43.0	43.00
0.6		47.24
0.75	55.0	53.38
0.8		55.36
0.9		59.24
1	63.0	63.00

Interaction parameter	6.00

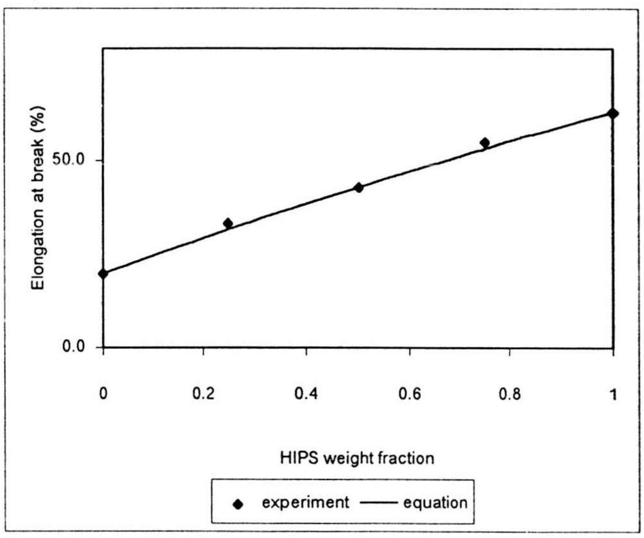


Fig. B.4.11 Elongation at break of HIPS/PC blend [67]

LPE/UHMWLPE

w.fraction	experiment	equation
0	5.1	5.10
0.1	7.5	7.26
0.2		9.07
0.3	9.7	10.52
0.4		11.61
0.5	12.4	12.35
0.6		12.73
0.7	14.0	12.76
0.8		12.43
0.9		11.74
1	10.7	10.70

Interaction parameter	17.80

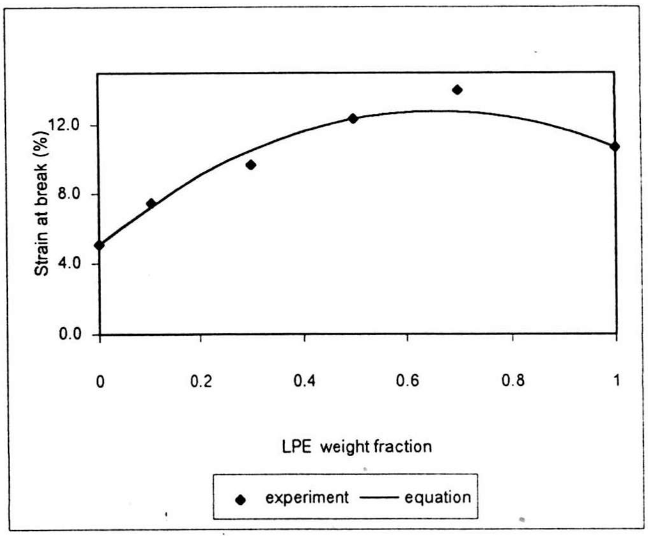


Fig. B.4.12 Strain at break of LPE/UHMWLPE blend [27]

B.5 Unpredictable Properties of Polymer Blends

PEI/PAR blend

w.fraction	experiment	equation
0	3350	3350
0.1	3400	3222
0.2	3250	3098
0.3	3150	2978
0.4	3000	2862
0.5	2750	2750
0.6	2840	2642
0.7	2700	2538
0.8	2500	2438
0.9	2430	2342
1	2250	2250

Interaction parameter	-200

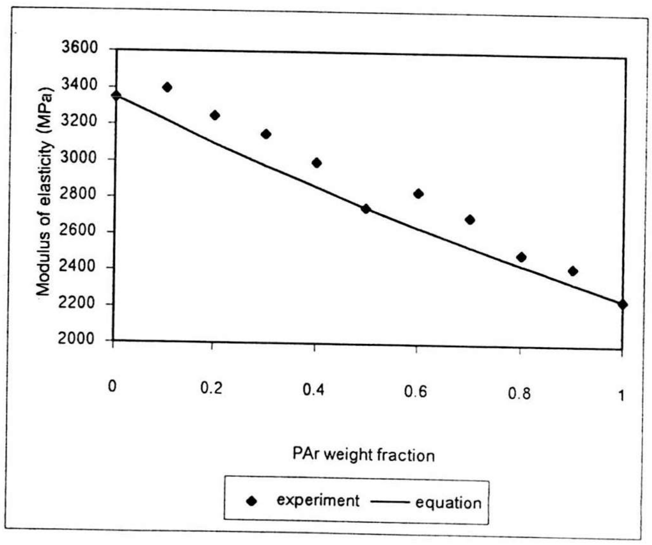


Fig. B.5.1 Modulus of elasticity of PEI/PAR blend [61]

LPE/PP blend

w.fraction	experiment	equation
0	575	575.0
0.1		617.4
0.25	655	651.6
0.3		677.6
0.4		695.4
0.5	705	705.0
0.6		706.4
0.75	727	699.6
0.8	740	684.6
0.9	710	661.4
1	630	630.0

Interaction parameter 410

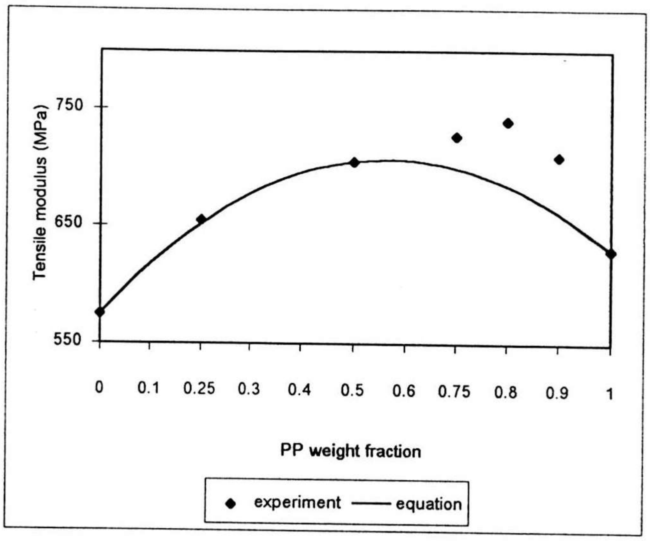


Fig. B.5.2 Tensile modulus of LDPE/PP blend [71]

PC/PAR blend

w.fraction	experiment	equation
0	46.0	47.5
0.1	46.8	49.8
0.2		51.6
0.25	50.6	52.3
0.4	52.0	53.5
0.5	53.6	53.6
0.6	56.3	53.2
0.75	56.3	51.5
0.8		50.7
0.9	53.0	48.6
1	47.5	46.0

Interaction parameter 27.4

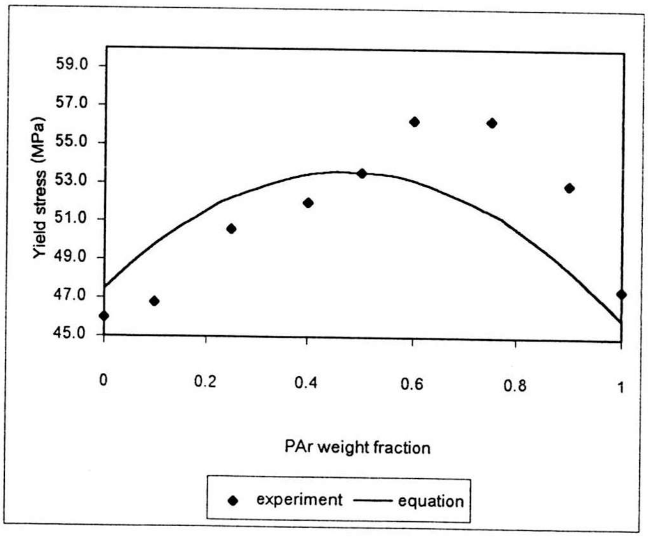


Fig. B.5.3 Yield stress of PC/PAR blend [26]

PUR/PEMA blend

w.fraction	experiment	equation
0	1.2	1.2
0.1	1.4	0.9
0.2	4.2	1.6
0.3	9.3	3.3
0.4	9.6	6.1
0.5	10.0	10.0
0.6	13.0	14.9
0.7	12.0	20.9
0.8	18.0	27.9
0.9	32.0	35.9
1	45.0	45.0

Interaction parameter	-52.4

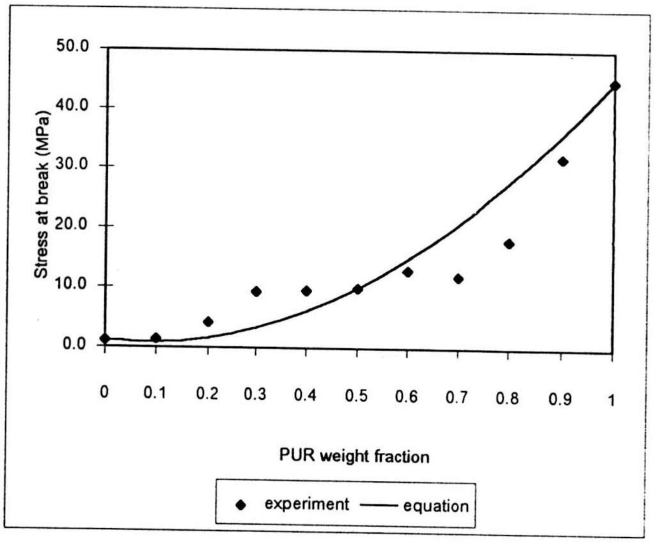


Fig. B.5.4 Stress at break of PUR/PEMA blend [50]

PC/SAN blend

w.fraction	experiment	equation
0	6400	6400.0
0.1		7083.2
0.2	6300	7664.8
0.3		8144.8
0.4	6400	8523.2
0.5	8800	8800.0
0.6		8975.2
0.7		9048.8
0.8	8570	9020.8
0.9		8891.2
1	8660	8660.0

Interaction parameter	5080

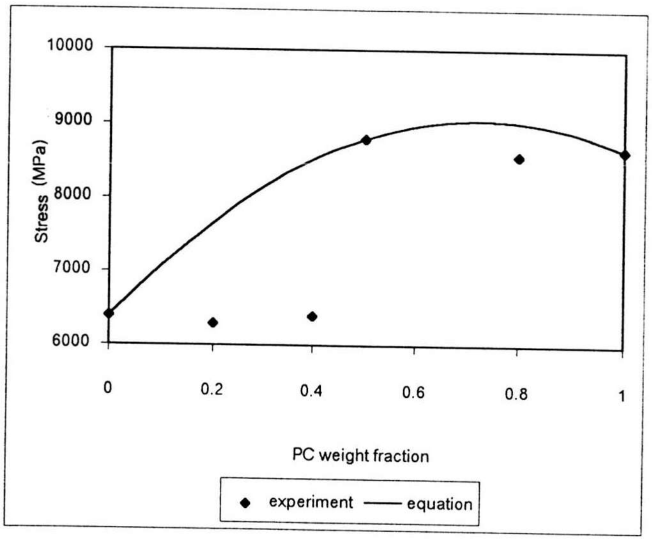


Fig. B.5.5 Stress of PC/SAN blend [68]

PAr/PA6 blend

w.fraction	experiment	equation
0	37.0	37.0
0.1	15.0	24.1
0.2		15.4
0.3	13.0	10.9
0.4		10.5
0.5	14.4	14.4
0.6		22.4
0.7	11.0	34.7
0.8		51.1
0.9	21.0	71.7
1	96.5	96.5

Interaction parameter	-209.4

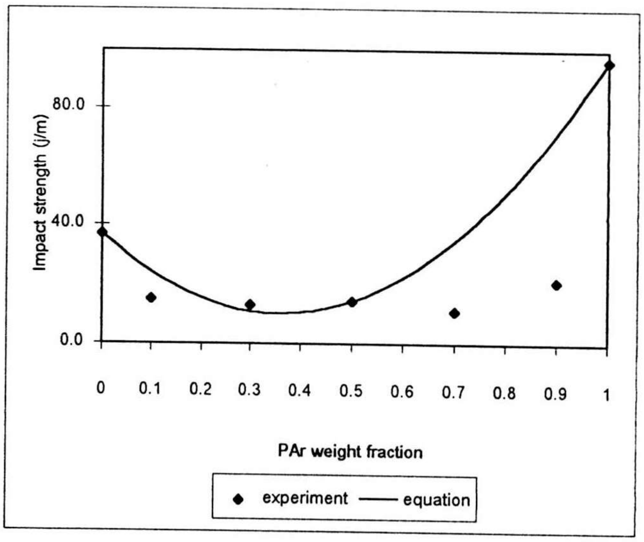


Fig. B.5.6 Impact strength of PAr/PA6 blend [36]

PMMA/Phenoxy blend

w.fraction	experiment	equation
0	0.6	0.55
0.1	0.7	-0.10
0.2		-0.34
0.3	1.1	-0.19
0.4		0.35
0.5	1.3	1.30
0.6		2.64
0.7	1.5	4.39
0.8		6.53
0.9	1.6	9.06
1	12.0	12.00

Interaction parameter	-19.9

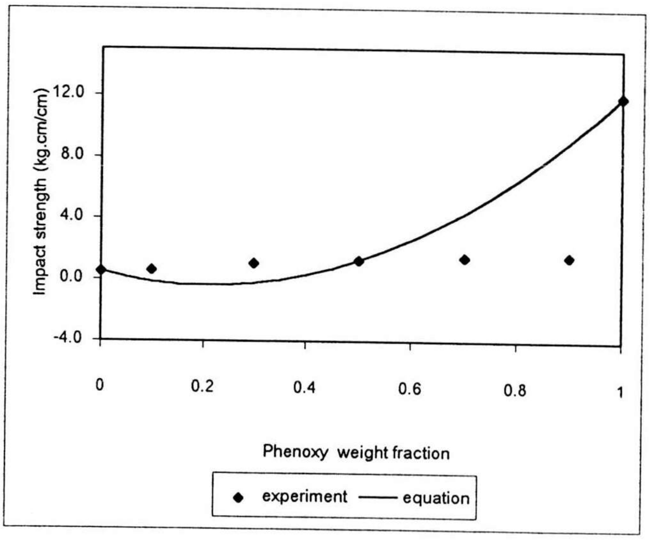


Fig. B.5.7 Impact strength of PMMA/Phenoxy blend [37]

SBS/MS blend

w.fraction	experiment	equation
0	20	20.0
0.1		23.6
0.25	61	27.5
0.3	54	28.4
0.4		29.6
0.5	30	30.0
0.6		29.6
0.7	20	28.4
0.8		26.4
0.9		23.6
1	20	20.0

Interaction parameter	40

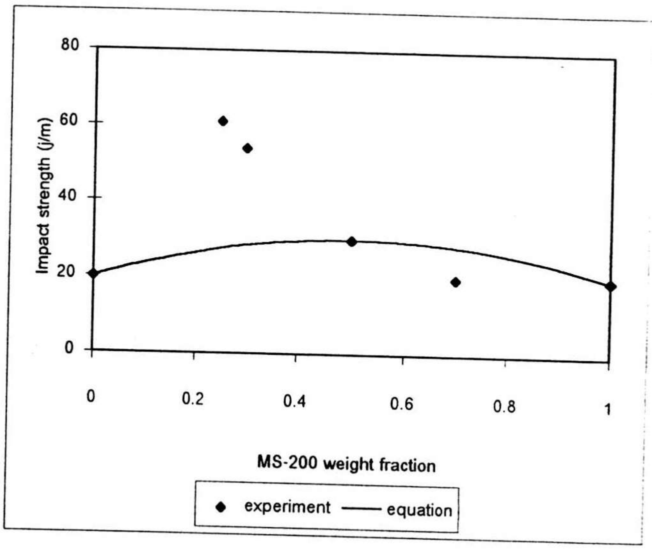


Fig. B.5.8 Impact strength of SBS/MS-200 blend [45]

PEI/PET blend

w.fraction	experiment	equation
0	60.0	60.0
0.1		51.8
0.25	42.3	41.4
0.3		38.5
0.4	33.0	33.3
0.5	29.2	29.2
0.6	17.7	26.1
0.75	15.4	23.3
0.8		22.9
0.9		22.8
1	23.8	23.8

Interaction parameter	-50.8

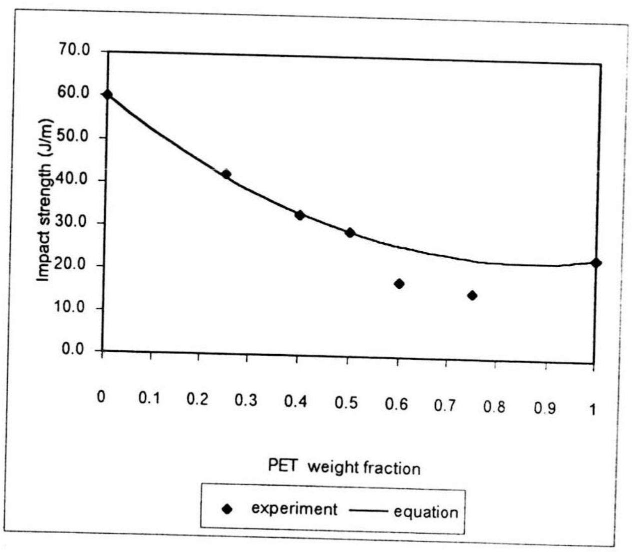


Fig. B.5.9 Impact strength of PEI/PET blend [48]

LLDPE/PP blend

w.fraction	experiment	equation
0	58.6	58.6
0.1	47.1	61.4
0.2	46.5	64.2
0.3		66.8
0.4	68.7	69.5
0.5	72.0	72.0
0.6	76.3	74.5
0.7		76.9
0.8	89.8	79.2
0.9	84.4	81.5
1	83.7	83.7

Interaction parameter	3.4

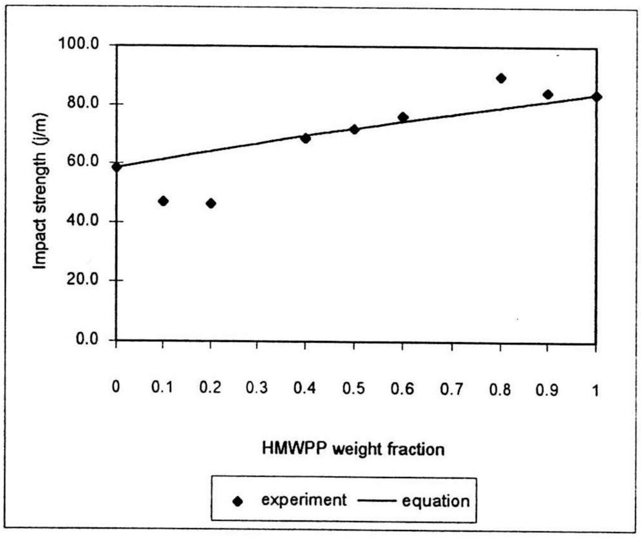


Fig. B.5.10 Impact strength of LLDPE/PP blend [51]

PC/ABS blend

w.fraction	experiment	equation
0	29	29.0
0.1	32	20.7
0.25		11.4
0.3	6	9.1
0.4		5.7
0.5	4	4.0
0.6		3.9
0.75	4	6.9
0.8		8.7
0.9	8	13.5
1	20	20.0

Interaction parameter	-82

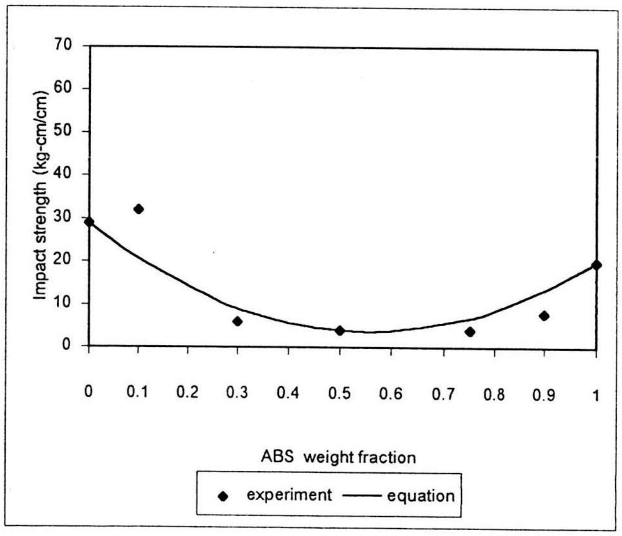


Fig. B.5.11 Impact strength of PC/ABS blend [53]

PC/PMMA blend

w.fraction	experiment	equation
0	0.1	0.10
0.1		-0.12
0.2		-0.20
0.3		-0.12
0.4		0.12
0.5	0.5	0.50
0.6		1.04
0.7	1.4	1.72
0.8		2.56
0.9	5.1	3.56
1	4.7	4.70

Interaction parameter	-7.6

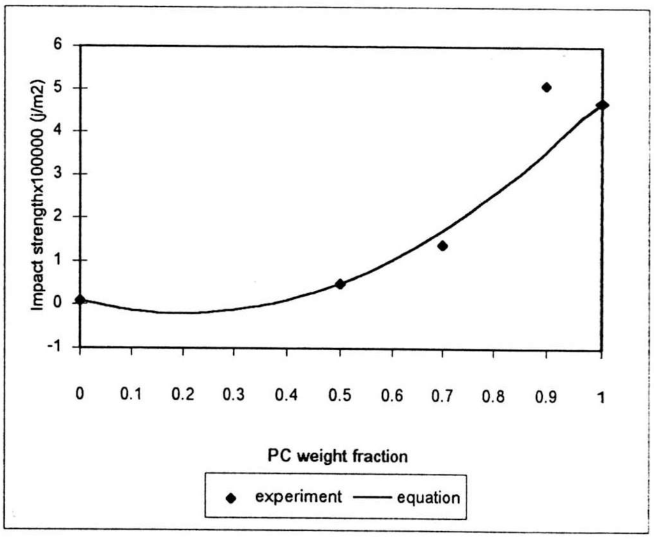


Fig. B.5.12 Impact strength of PC/PMMA blend [56]

PC/SAN blend

w.fraction	experiment	equation
0	0.70	0.70
0.1		-0.60
0.2	0.22	-1.28
0.3	6.00	-1.33
0.4	0.33	-0.76
0.5	0.44	0.44
0.6	0.55	2.26
0.7		4.71
0.8	1.33	7.78
0.9		11.48
1	15.80	15.80

Interaction parameter	-31.24

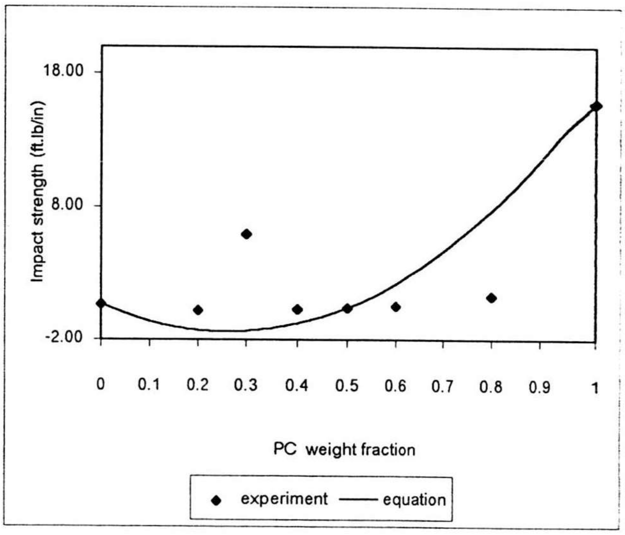


Fig. B.5.13 Impact strength of PC/SAN blend [68]

PA6/PP blend

w.fraction	experiment	equation
0	50	50.0
0.1	62	52.4
0.2	73	53.8
0.3	58	54.4
0.4		54.2
0.5	53	53.0
0.6		51.0
0.7	35	48.0
0.8	28	44.2
0.9	26	39.6
1	34	34.0

Interaction parameter	44

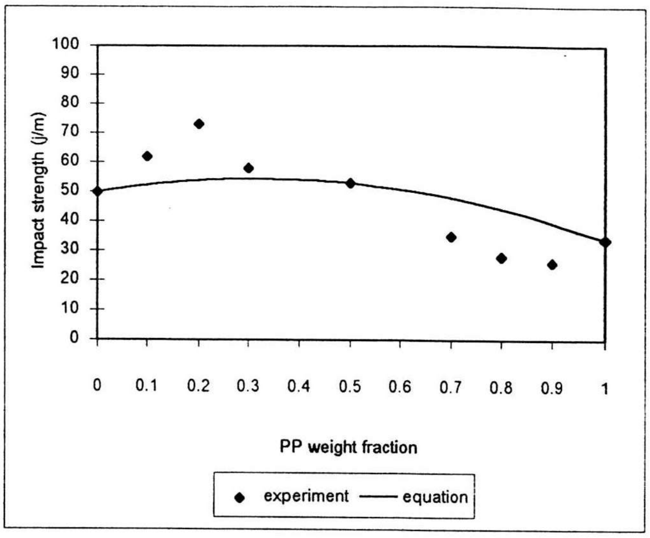


Fig. B.5.14 Impact strength of PA6/PP blend [39]

LPE/PP blend

w.fraction	experiment	equation
0	1600.0	1600.0
0.1		1076.4
0.25	14.5	484.2
0.3		338.2
0.4		123.7
0.5	12.2	12.2
0.6		3.7
0.75	10.8	184.2
0.8	9.8	295.8
0.9	16.0	596.4
1	1000.0	1000.0

Interaction parameter	-5151.2

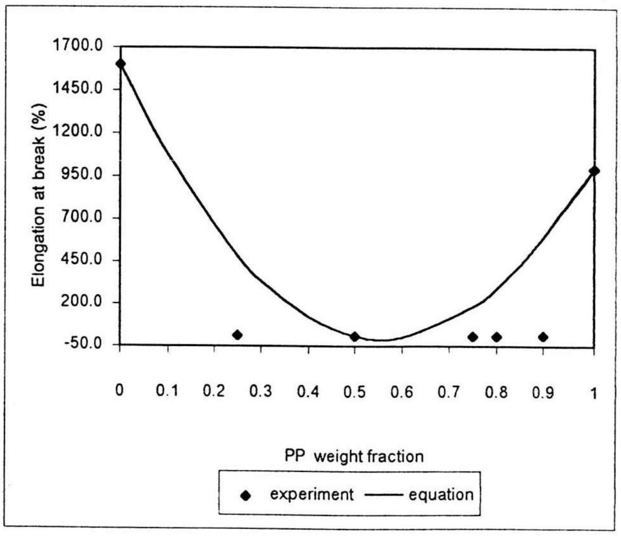


Fig. B.5.15 Elongation at break of LPE/PP blend [71]

PP/ULDPE blend

w.fraction	experiment	equation
0	625	625.0
0.1	548	630.5
0.2		631.5
0.3	524	628.1
0.4		620.3
0.5	608	608.0
0.6		591.3
0.7	620	570.1
0.8		544.5
0.9	580	514.5
1	480	480.0

Interaction parameter	222

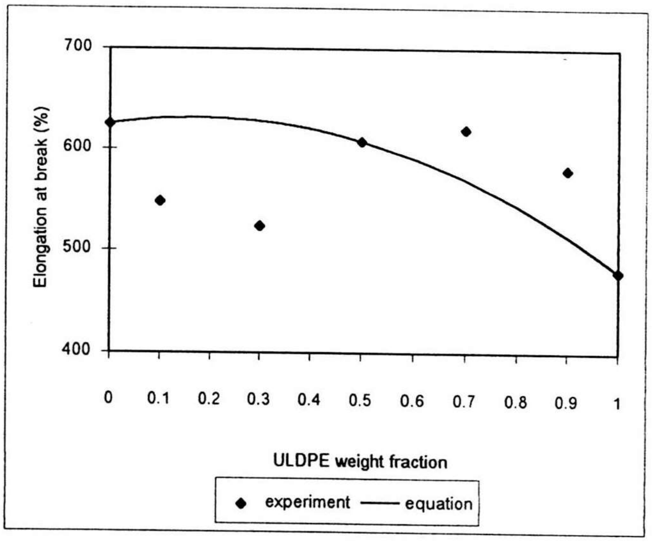


Fig. B.5.16 Elongation at break of ULDPE/PP blend [29]

PBT/PAr blend

w.fraction	experiment	equation
0	240	240
0.1	240	201
0.2	185	166
0.3	140	135
0.4	100.5	108
0.5	85	85
0.6		66
0.7		51
0.8		40
0.9		33
1	30	30

Interaction parameter	-200

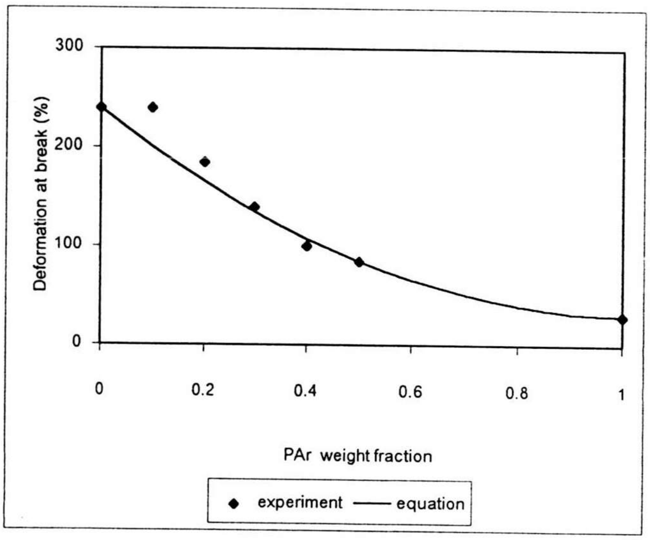


Fig. B.5.17 Deformation at break of PBT/PAr blend [74]

PAr/PA6 blend

w.fraction	experiment	equation
0	37.0	37.0
0.1	12.7	27.0
0.2		18.8
0.3	5.5	12.5
0.4		8.1
0.5	5.5	5.5
0.6		4.8
0.7	5.5	5.9
0.8		8.9
0.9	13.6	13.8
1	20.5	20.5

Interaction parameter	-93

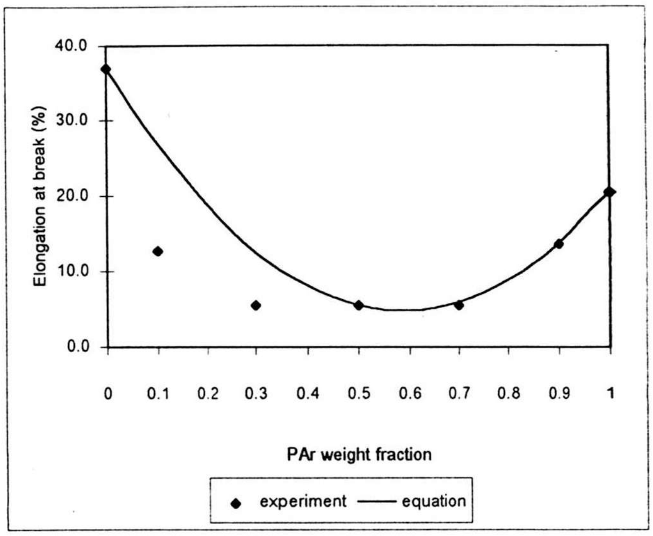


Fig. B.5.18 Elongation at break of PAr/PA6 blend [36]

PMMA/Phenoxy blend

w.fraction	experiment	equation
0	4	4.0
0.1	5	14.2
0.2		23.2
0.3	10	30.8
0.4		37.0
0.5	42	42.0
0.6		45.6
0.7	44	48.0
0.8		49.0
0.9	46	48.6
1	47	47.0

Interaction parameter	66

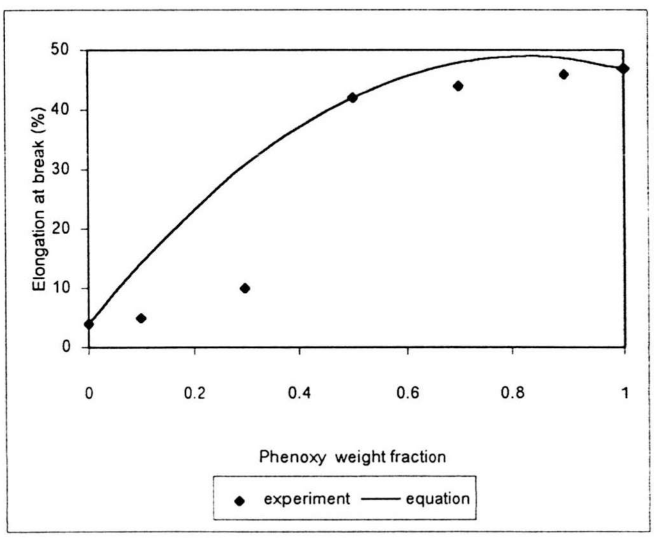


Fig. B.5.19 Elongation at break of PMMA/Phenoxy blend [37]

PA6/PP blend

w.fraction	experiment	equation
0	90	90.0
0.1		61.2
0.2	2.5	38.2
0.3	3	20.8
0.4		9.0
0.5	3	3.0
0.6		2.6
0.7	4	8.0
0.8	5	19.0
0.9	7.5	35.6
1	58	58.0

Interaction parameter	-284

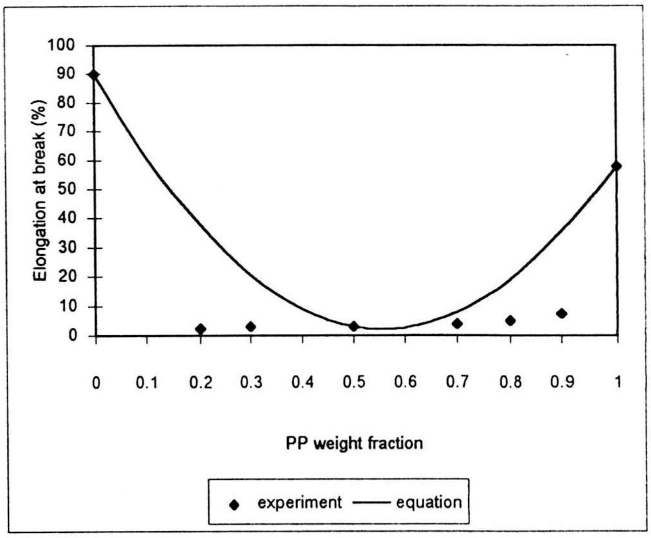


Fig. B.5.20 Elongation at break of PA6/PP blend [39]

PP/NBR

w.fraction	experiment	equation
0	1267	1265.0
0.1		924.8
0.2		632.5
0.3	38.64	388.0
0.4		191.3
0.5	43.45	42.4
0.6		-58.6
0.7	95.58	-111.8
0.8		-117.1
0.9		-74.7
1	15.6	15.6

Interaction parameter	-2391.4

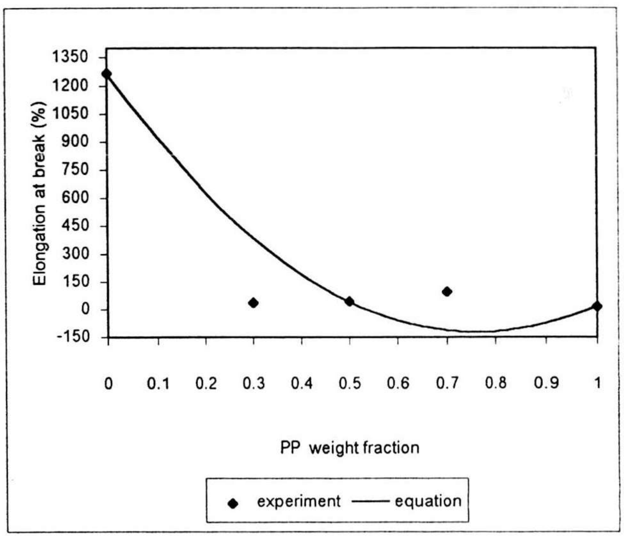


Fig. B.5.21 Elongation at break of PP/NBR blend [40]

PES/PMIA blend

w.fraction	experiment	equation
0	8	8.0
0.1		51.0
0.2	8.5	84.6
0.3		109.0
0.4	80	124.2
0.5	130	130.0
0.6	102	126.6
0.7	110	113.8
0.8		91.8
0.9		60.6
1	20	20.0

Interaction parameter	464

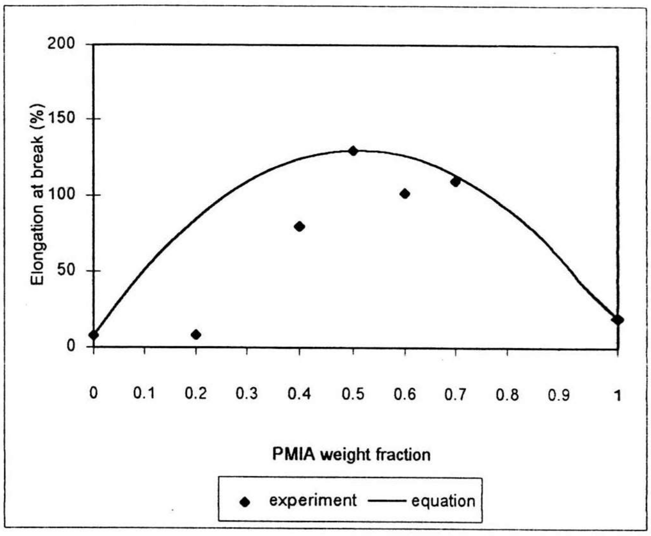


Fig. B.5.22 Elongation at break of PES/PMIA blend [41]

PPS/PSF

w.fraction	experiment	equation
0	5.4	5.4
0.1		44.7
0.2		77.8
0.3	14.2	104.7
0.4		125.4
0.5	140	140.0
0.6		148.4
0.7	125	150.6
0.8		146.6
0.9		136.4
1	120	120.0

Interaction parameter	309.2

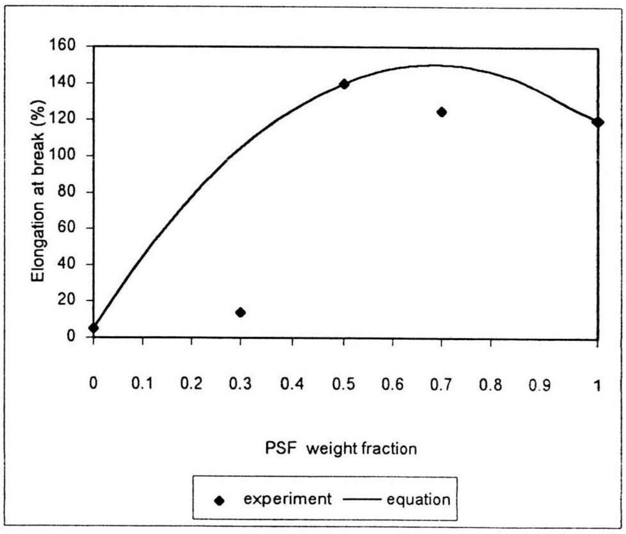


Fig. B.5.23 Elongation at break of PPS/PSF blend [42]

PUR/PEMA blend

w.fraction	experiment	equation
0	9.8	9.8
0.1	12	29.9
0.2	22	49.9
0.3	44	69.9
0.4	75	90.0
0.5	110	110.0
0.6	230	130.0
0.7	360	150.0
0.8	410	170.0
0.9	280	190.0
1	210	210.0

Interaction parameter	0.4

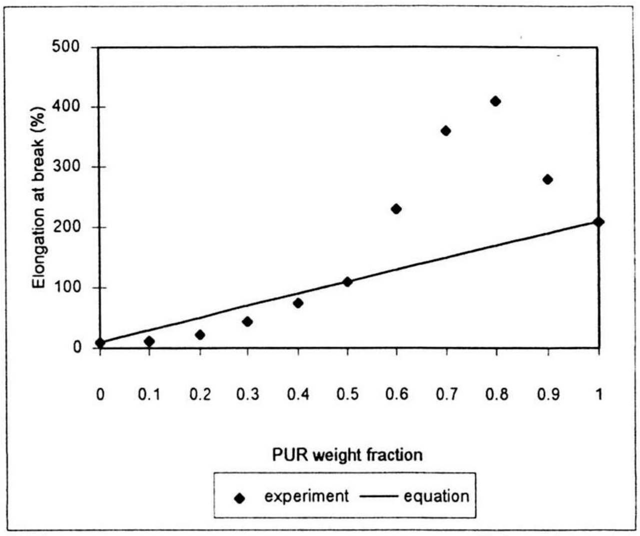


Fig. B.5.24 Elongation at break of PUR/PEMA blend [50]

PA6/PP

w.fraction	experiment	equation
0	83	83.0
0.1		59.4
0.2	7	39.9
0.3		24.4
0.4	4	12.9
0.5	5.5	5.5
0.6	7	2.1
0.7	11	2.8
0.8		7.5
0.9		16.2
1	29	29.0

Interaction parameter	-202

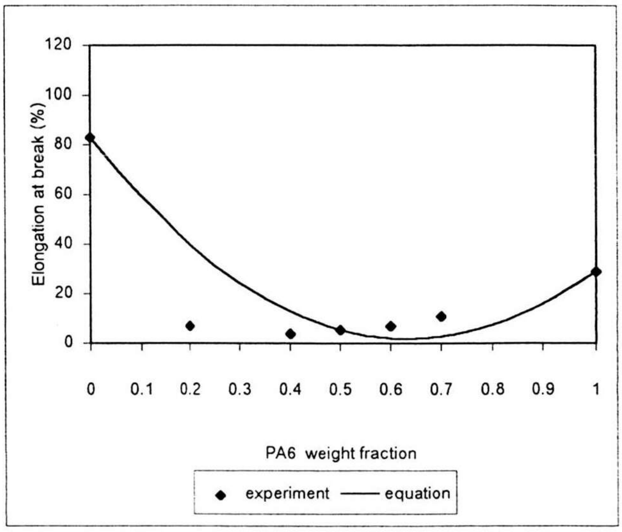


Fig. B.5.25 Elongation at break of PA6/PP blend [55]

PC/PMMA blend

w.fraction	experiment	equation
0	8.7	8.7
0.1		10.3
0.2		13.3
0.3	12	17.6
0.4		23.1
0.5	30	30.0
0.6		38.2
0.7	86	47.7
0.8		58.5
0.9	85	70.6
1	84	84.0

Interaction parameter	-65.4

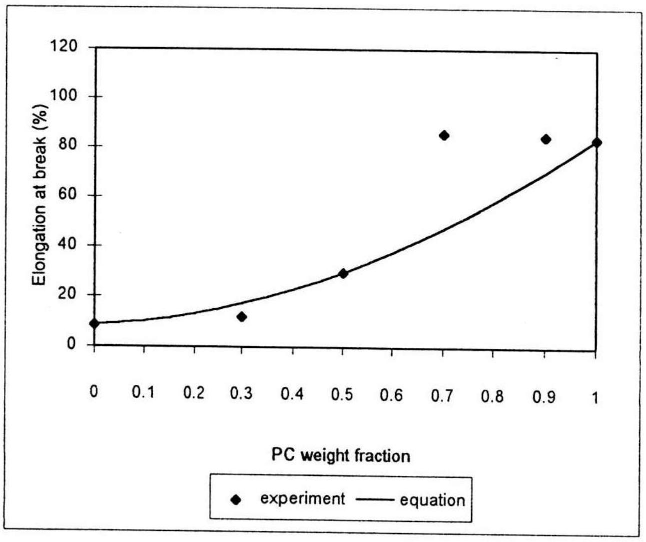


Fig. B.5.26 Elongation at break of PC/PMMA blend [56]

PVC/PI

w.fraction	experiment	equation
0	160	160.0
0.1		140.1
0.2	80	121.1
0.3		103.1
0.4	95	86.1
0.5	70	70.0
0.6	40	54.9
0.7		40.7
0.8	10	27.5
0.9		15.3
1	4	4.0

Interaction parameter	-48

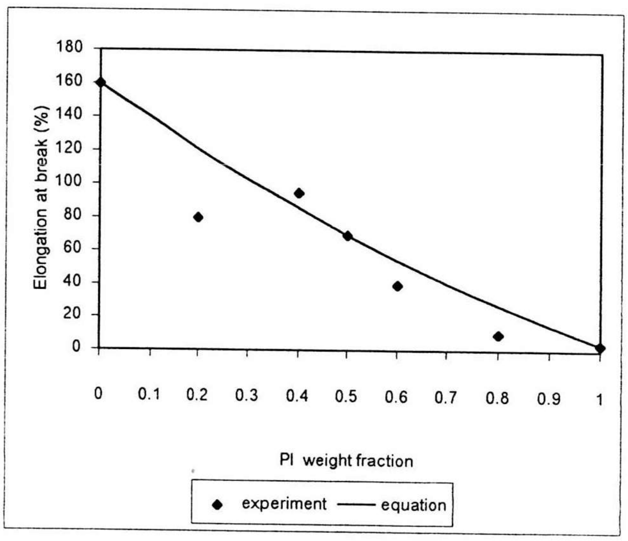


Fig. B.5.27 Elongation at break of PVC/PI blend [57]

PEI/PAr blend

w.fraction	experiment	equation
0	14	14.0
0.1	16.5	15.4
0.2	16	16.6
0.3	15	17.4
0.4	26	17.8
0.5	18	18.0
0.6	26	17.8
0.7	18	17.4
0.8	26	16.6
0.9	28	15.4
1	14	14.0

Interaction parameter	16

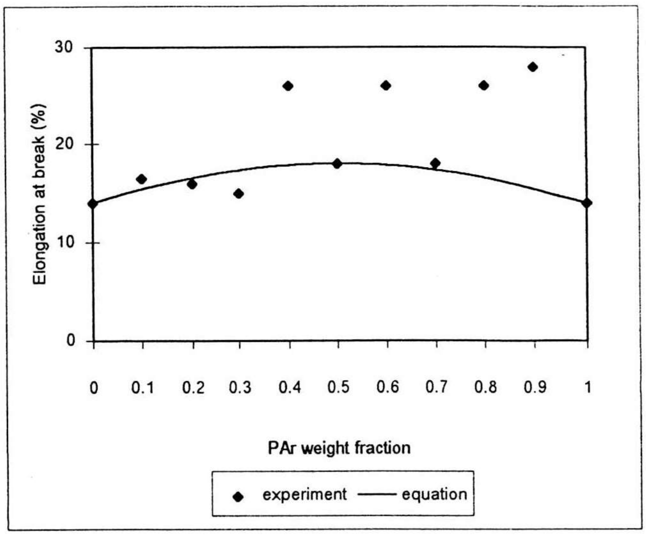


Fig. B.5.28 Elongation at break of PEI/PAr blend [61]

LDPE/ABS

w.fraction	experiment	equation
0	16	16.0
0.1	10	-18.9
0.2	5	-37.4
0.3		-39.7
0.4	4	-25.8
0.5	4.5	4.5
0.6	6	51.0
0.7		113.9
0.8	50	193.0
0.9		288.3
1	400	400.0

Interaction parameter	-814

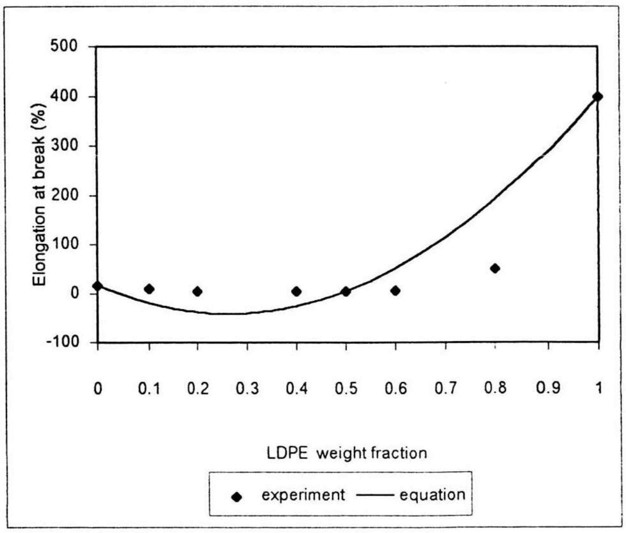


Fig. B.5.29 Elongation at break of LDPE/ABS blend [64]

PC/SAN blend

w.fraction	experiment	equation
0	6400	6400.0
0.1		6795.2
0.2	6300	7152.8
0.3		7472.8
0.4	6400	7755.2
0.5	8000	8000.0
0.6	8800	8207.2
0.7		8376.8
0.8	8570	8508.8
0.9		8603.2
1	8660	8660.0

Interaction parameter	1880

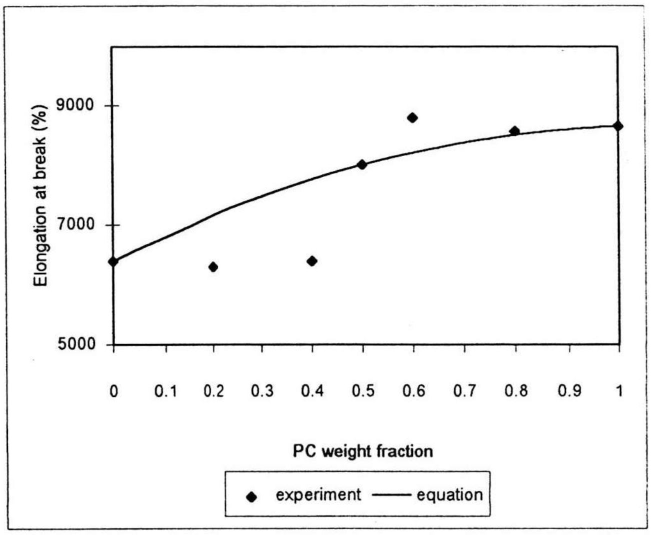


Fig. B.5.30 Elongation at break of PC/SAN blend [68]

HDPE/PP

w.fraction	experiment	equation
0	400	400.0
0.1		319.0
0.25	95	221.9
0.3		196.0
0.4		154.0
0.5	125	125.0
0.6		109.0
0.7		106.0
0.75	170	109.4
0.9		139.0
1	175	175.0

Interaction parameter	-650

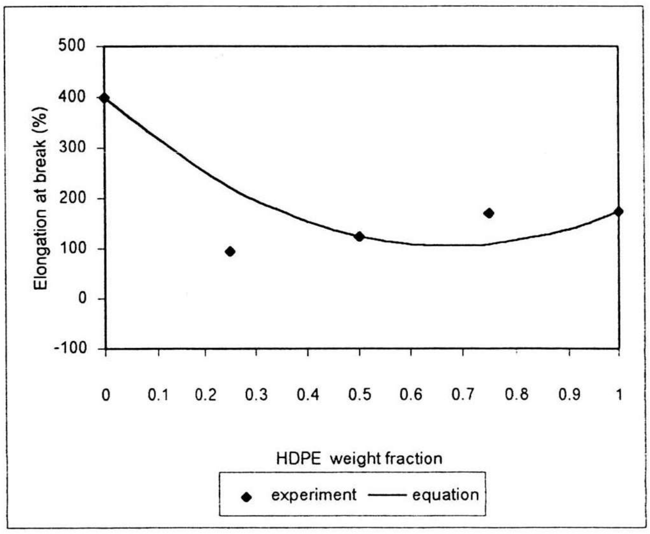


Fig. B.5.31 Elongation at break of HDPE/PP blend [70]

APPENDIX C

Mechanical Properties of HDPE/PP blends

C. 1 Tensile Properties of HDPE(GA3750)/PP(1102H) Blends

Table C.1 Tensile properties of HDPE(GA3750)/PP(1102H) blended at 0:100, 20:80, 40:60, 50:50, 60:40, 80:20, 100:0 compositions.

HDPE:PP Composition	Specimen Number	Modulus (MPa)	Yield Strength (MPa)	Elongation (%)
A-1(0:100),	1	1547	31.63	268.80
B-1(0:100),	2	1550	30.76	313.80
C-1(0:100),	3	1379	31.47	129.40
D-1(0:100)	4	1802	30.28	264.30
	5	1431	30.97	268.80
	6	1902	33.11	115.20
	7	1341	30.24	336.90
	8	1318	30.11	352.30
	9	1268	30.47	293.80
	10	1255	27.74	380.00
Average		1479.30	30.68	272.33
STDEV		222.33	1.37	87.91
95% confident		+/- 159.04	+/- 0.98	+/- 62.88

Table C.1 Continued

HDPE:PP Composition	Specimen Number	Modulus (MPa)	Yield Strength (MPa)	Elongation (%)
A-2(20:80)	1	1201	30.22	8.942
	2	1194	30.13	58.62
	3	1166	29.22	94.92
	4	1450	29.79	12.88
	5	1161	29.14	14.52
	6	1125	30.67	11.62
	7	1253	29.10	124.2
	8	1036	28.76	93.69
	9	1164	29.19	150.8
	10	1311	29.59	59.9
Average		1206.10	29.58	63.00
STDEV		112.44	0.61	51.50
95% confident		+/- 80.43	+/- 0.43	+/- 36.84
A-3(40:60)	1	1151	27.07	6.94
	2	1444	27.51	4.68
	3	1227	27.44	7.09
	4	1433	24.36	3.61
	5	1126	27.12	5.61
	6	1395	26.82	4.89
	7	1263	28.07	5.09
	8	1354	28.20	5.37
	9	1392	26.21	3.69
	10	1358.00	24.69	3.75
Average		1314.30	26.75	5.07
STDEV		115.14	1.31	1.24
95% confident		+/- 82.36	+/- 0.94	+/- 0.89

Table C.1 Continued

HDPE:PP Composition	Specimen Number	Modulus (MPa)	Yield Strength (MPa)	Elongation (%)
A-4(50:50)	1	1106	28.31	4.92
	2	1031	26.93	6.45
	3	1032	28.12	6.02
	4	1173	26.1	7.48
	5	1062	27.52	6.00
	6	973	27.63	6.42
	7	1319	26.05	4.12
	8	1170	28.03	5.42
	9	1317	27.71	4.23
	10	977	26.46	8.64
Average		1116.0	27.27	5.97
STDEV		126.86	0.84	1.40
95% confident		+/- 90.74	+/- 0.60	+/- 1.00
A-5(60:40)	1	1312	25.00	4.87
	2	1283	29.45	5.46
	3	1316	24.90	7.83
	4	1424	26.40	3.75
	5	1017	25.85	4.01
	6	1172	29.38	5.97
	7	1305	23.96	3.05
	8	1374	28.18	5.57
	9	1207	25.64	3.85
	10	1202	26.74	3.69
Average		1261.20	26.55	4.81
STDEV		116.06	1.89	1.44
95% confident		+/- 83.02	+/- 1.35	+/- 1.03

Table C.1 Continued

HDPE:PP Composition	Specimen Number	Modulus (MPa)	Yield Strength (MPa)	Elongation (%)
A-6(80:20)	1	1166	22.2	36.46
	2	1165	25.93	40.77
	3	1133	20.33	61.38
	4	986	26.53	29.08
	5	996	26.03	71.54
	6	1173	25.27	18.62
	7	919	23.97	22.31
	8	940	24.68	16.62
	9	1111	24.77	33.38
	10	1231	26.67	35.85
Average		1081.9	24.64	36.60
STDEV		111.08	2.02	17.78
95% confident		+/- 79.46	+/- 1.44	+/- 12.73
A-7(100:.)	1	517.9	18.82	419.6
	2	823.7	19.03	316.1
	3	614.5	20.31	431.9
	4	959.7	21.25	346.5
	5	727.3	21.09	366.7
	6	961.8	22.46	343.1
	7	942.6	22.19	415.1
	8	600.5	21.25	443.2
	9	1033	20.7	171.0
	10	1097	22.93	299.2
Average		827.80	21.00	355.24
STDEV		201.78	1.36	81.86
95% confident		+/- 144.33	+/- 0.97	+/- 12.73

C.2 Tensile Properties of HDPE(G2855)/PP(1102H) Blends

Table C.2 Tensile properties of HDPE(G2855)/PP(1102H) blended at 20:80, 40:60, 50:50, 60:40, 80:20, 100:0 compositions.

HDPE:PP Composition	Specimen Number	Modulus (MPa)	Yield Strength (MPa)	Elongation (%)
B-2(20:80)	1	1043	27.03	8.90
	2	1437	31.07	7.12
	3	1456	31.24	9.20
	4	1331	30.45	6.74
	5	1289	30.88	6.92
	6	1442	31.17	6.55
	7	1548	31.75	7.20
	8	1395	30.40	8.09
	9	1218	26.75	8.90
	10	1345	31.02	6.69
Average		1350.40	30.18	7.63
STDEV		143.09	1.78	1.04
95% confident		+/- 102.35	+/- 1.27	+/- 0.74
B-3(40:60)	1	1235	27.07	8.39
	2	1363	25.59	5.66
	3	1189	27.17	9.22
	4	1331	26.14	5.20
	5	1370	29.33	4.78
	6	1436	28.08	4.17
	7	1538	25.78	5.03
	8	1293	25.45	5.49
	9	1370	27.23	5.18
	10	1362	25.33	6.05
Average		1348.7	26.72	5.92
STDEV		98.09	1.30	1.62
95% confident		+/- 70.16	+/- 0.93	+/- 1.16

Table C.2 Continued

HDPE:PP Composition	Specimen Number	Modulus (MPa)	Yield Strength (MPa)	Elongation (%)
B-4(50:50)	1	1483	25.35	6.37
	2	1352	27.80	7.80
	3	1107	30.45	4.53
	4	1169	28.29	6.94
	5	1295	22.97	5.39
	6	1480	26.00	6.26
	7	1192	30.78	4.78
	8	943	27.31	6.45
	9	1353	21.74	5.57
	10	1786.00	29.50	5.89
Average		1316.00	27.02	6.00
STDEV		235.37	3.03	0.99
95% confident		+/- 235.37	+/- 3.03	+/- 0.99
B-5(60:40)	1	1386	27.10	3.70
	2	1337	27.79	4.30
	3	1440	26.65	3.77
	4	1373	28.82	4.52
	5	1321	25.89	3.45
	6	1306	26.92	4.82
	7	1226	23.90	3.12
	8	1156	20.66	5.80
	9	1383	26.57	3.54
	10	1221	28.24	5.31
Average		1314.90	26.25	4.23
STDEV		89.00	2.39	0.87
95% confident		+/- 63.66	+/- 1.71	+/- 0.62

Table C.2 Continued

HDPE:PP Composition	Specimen Number	Modulus (MPa)	Yield Strength (MPa)	Elongation (%)
B-6(80:20)	1	1175	27.30	24.15
	2	1379	27.90	10.88
	3	1433	26.93	30.92
	4	1139	25.64	10.89
	5	1293	27.05	7.51
	6	1372	27.24	40.92
	7	1223	26.83	10.22
	8	1318	26.63	5.46
	9	841	28.63	26.46
	10	1294	27.12	9.22
Average		1246.70	27.13	17.66
STDEV		169.73	0.78	12.05
95% confident		+/- 121.41	+/- 0.67	+/- 8.62
B-7(100:0)	1	1129	22.39	641.50
	2	1391	24.92	587.70
	3	1272	23.77	74.90
	4	1294	24.57	131.80
	5	1159	22.80	535.40
	6	1289	23.95	266.20
	7	1179	22.69	758.50
	8	1220	23.61	24.80
	9	1152	23.82	163.10
	10	1443	24.72	589.20
Average		1252.8	23.72	377.31
STDEV		105.12	0.88	271.51
95% confident		+/-75.20	+/- 0.67	+/- 194.22

C.3 Tensile Properties of HDPE(N3260)/PP(1102H) Blends

Table C.3 Tensile properties of HDPE(N3260)/PP(1102H) blended at 20:80, 40:60, 50:50, 60:40, 80:20, 100:0 compositions.

HDPE:PP Composition	Specimen Number	Modulus (MPa)	Yield Strength (MPa)	Elongation (%)
C-2(20:80)	1	908	34.23	11.72
	2	1303	34.78	11.49
	3	1232	34.97	30.46
	4	1919	35.38	76.15
	5	1429	31.68	6.32
	6	1464	36.53	12.91
	7	1223	36.43	11.57
	8	1566	35.90	42.46
	9	1277	36.49	30.15
	10	1190	34.19	10.80
Average		1351.10	35.06	24.40
STDEV		268.37	1.49	21.63
95% confident		+/- 65.15	+/- 1.52	+/- 40.39
C-3(40:60)	1	890	33.60	11.34
	2	1272	35.32	11.90
	3	1463	34.81	10.23
	4	1481	38.07	9.43
	5	1450	34.96	8.73
	6	1184	32.90	7.89
	7	1409	34.20	8.49
	8	1188	33.76	9.38
	9	1270	32.72	11.04
	10	1094	34.12	8.11
Average		1270.10	34.45	9.65
STDEV		189.44	1.53	1.41
95% confident		+/- 56.06	+/- 0.88	+/- 0.87

Table C.3 Continued

HDPE:PP Composition	Specimen Number	Modulus (MPa)	Yield Strength (MPa)	Elongation (%)
C-4(50:50)	1	1198	25.00	4.76
	2	1822	25.68	3.94
	3	2074	27.64	4.68
	4	1814	24.66	3.23
	5	1671	26.63	5.15
	6	1748	26.72	4.01
	7	1929	24.40	3.04
	8	1692	25.69	3.96
	9	1776	25.82	3.85
	10	1809.00	22.97	2.55
Average		1753.30	25.52	3.92
STDEV		227.22	1.34	0.81
95% confident		+/- 103.43	+/- 0.96	+/- 0.58
C-5(60:40)	1	1160	28.83	9.74
	2	1128	28.55	7.40
	3	1339	30.43	7.77
	4	1373	28.46	8.50
	5	1291	29.56	29.69
	6	1196	28.29	8.77
	7	1238	29.38	6.29
	8	1281	29.87	6.92
	9	1272	30.74	11.74
	10	1561	28.82	7.34
Average		1283.90	29.29	10.42
STDEV		123.58	0.85	6.95
95% confident		+/- 75.53	+/- 1.10	+/- 0.86

Table C.3 Continued

HDPE:PP Composition	Specimen Number	Modulus (MPa)	Yield Strength (MPa)	Elongation (%)
C-6(80:20)	1	1280	22.01	128.80
	2	1232	26.75	443.10
	3	1248	23.19	183.10
	4	1162	19.62	635.40
	5	1060	20.55	424.60
	6	1216	26.57	449.20
	7	1245	20.71	540
	8	1036	25.86	104.20
	9	962.9	20.69	589.20
	10	1109	26.10	429.20
Average		1155.09	23.21	392.68
STDEV		107.64	2.85	189.77
95% confident		+/- 77.00	+/- 2.04	+/- 135.74
C-7(100:0)	1	1225	20.29	766.20
	2	1228	21.34	763.10
	3	1276	23.69	626.00
	4	1047	22.87	757.00
	5	1179	24.46	646.00
	6	937	23.87	705.00
	7	1217	20.85	724.60
	8	1205	21.40	766.20
	9	1135	25.79	629.00
	10	1092	24.43	635.00
Average		1154.1	22.90	701.81
STDEV		102.92	1.84	61.69
95% confident		+/- 73.62	+/- 1.31	+/- 44.13

C.4 Tensile Properties of HDPE(V1160)/PP(1102H) Blends

Table C.4 Tensile properties of HDPE(V1160)/PP(1102H) blended at 20:80, 40:60, 50:50, 60:40, 80:20, 100:0 compositions.

HDPE:PP Composition	Specimen Number	Modulus (MPa)	Yield Strength (MPa)	Elongation (%)
D-2(20:80)	1	1132	32.39	7.29
	2	1375	30.59	61.38
	3	1135	31.06	6.68
	4	1180	33.45	34.15
	5	1446	30.61	9.84
	6	1037	24.45	12.62
	7	1036	29.29	8.35
	8	1350	30.69	78.46
	9	1399	30.25	8.80
	10	1556	32.15	8.13
Average		1264.6	30.49	23.57
STDEV		182.87	2.44	26.04
95% confident		+/- 130.81	+/- 1.74	+/- 18.62
D-3(40:60)	1	1250	30.37	5.71
	2	1254	24.57	3.23
	3	1383	28.24	4.91
	4	1439	26.39	3.54
	5	1093	24.24	3.19
	6	1380	29.67	5.69
	7	1320	26.72	4.04
	8	1308	22.68	2.54
	9	1447	27.59	4.04
	10	1394	25.30	3.39
Average		1326.80	26.58	4.03
STDEV		107.39	2.45	1.08
95% confident		+/- 76.82	+/- 1.75	+/- 0.78

Table C.4 Continued

HDPE:PP Composition	Specimen Number	Modulus (MPa)	Yield Strength (MPa)	Elongation (%)
D-4(50:50)	1	1043	21.71	15.38
	2	1231	30.53	8.030
	3	930	27.26	15.32
	4	1264	28.75	7.88
	5	1387	25.63	8.07
	6	1435	26.77	8.03
	7	1262	28.94	29.23
	8	1109	27.19	11.68
	9	1033	28.32	9.15
	10	872.00	27.26	6.25
Average		1156.6	27.24	11.90
STDEV		189.02	2.37	6.87
95% confident		+/- 135.21	+/- 1.70	+/- 4.91
D-5(60:40)	1	1401	23.41	3.34
	2	1337	21.56	3.14
	3	1513	24.81	11.70
	4	1219	22.22	3.22
	5	1123	26.28	5.05
	6	1084	27.03	5.06
	7	1292	27.49	6.01
	8	1485	26.83	5.43
	9	1255	23.40	5.18
	10	1253	24.42	4.92
Average		1296.2	24.75	5.30
STDEV		141.37	2.10	2.45
95% confident		+/- 101.12	+/- 1.50	+/- 1.76

Table C.4 Continued

HDPE:PP Composition	Specimen Number	Modulus (MPa)	Yield Strength (MPa)	Elongation (%)
D-6(80:20)	1	817	23.82	3.45
	2	1153	20.72	2.40
	3	886	22.47	3.17
	4	1186	23.00	3.83
	5	1047	19.22	8.49
	6	961	21.90	8.86
	7	1195	24.62	2.62
	8	1316	26.13	4.46
	9	1653	22.36	2.72
	10	1193	24.53	3.87
Average		1140.70	22.88	4.41
STDEV		238.47	2.02	2.33
95% confident		+/- 120.53	+/- 1.81	+/- 1.67
D-7(100:0)	1	1117	22.51	164.30
	2	1311	22.79	156.30
	3	1337	23.86	25.10
	4	1045	21.82	97.20
	5	1403	23.94	82.80
	6	1433	23.47	143.70
	7	1201	22.24	218.50
	8	1267	22.70	164.90
	9	1346	24.50	183.10
	10	1333	21.93	64.80
Average		1279.30	22.98	130.07
STDEV		123.88	0.92	60.08
95% confident		+/- 88.61	+/- 0.66	+/- 42.97

APPENDIX D

Calculation of intrinsic viscosity (ASTM 1601)

D.1 Relative viscosity (viscosity ratio)

calculation of the relative viscosity for each concentration is measured from the average efflux time as follows:

$$\eta_r = t/t_0$$

where

η_r = relative viscosity

t = average efflux time in seconds of solution

t = average efflux time in seconds of pure solvent

D.2 Inherent viscosity (logarithmic viscosity number)

Calculation of the inherent viscosity for each concentration is measured as follows:

$$\eta_{inh} = \ln \eta_r / C$$

where

η_{inh} = inherent viscosity at concentration C

$\ln \eta_r$ = natural logarithm of the relative viscosity

C = concentration in grams/100 ml of solution

D.3 Specific viscosity

$$\eta_{sp} = \eta_r - 1$$

where

η_{sp} = specific viscosity

D.4 Reduced viscosity (viscosity number)

$$\eta_{red} = \eta_{sp} / C$$

where

η_{red} = reduced viscosity

D.5 Intrinsic viscosity (limiting viscosity number)

The four logarithmic viscosity numbers are plotted versus their respective concentrations on rectilinear graph paper and then the four reduced viscosity numbers are plotted versus their respective concentrations on the same graph. The slopes of these two lines will not be the same, but they converge to the same value at zero intercept of the line at zero concentration.

D.6 Viscosity measurement of polypropylene and high density polyethylene

Table D.6.1 Viscosity measurement of PP(1102H) at 135 ^{0}C

Concentration ($g.dl^{-1}$)	t_1	t_2	t_3	t_{avg}	η_r	η_{sp}	$\ln \eta_r / C$	η_{sp}/C
solvent	212.35	217.85	209.25	213.15				
0.08	250.65	254.16	256.29	253.70	1.1902	0.1902	2.3780	2.1770
0.16	313.66	309.25	305.85	309.59	1.4524	0.4524	2.8277	2.3328
0.24	394.44	394.43	372.87	387.25	1.8168	0.8168	3.4033	2.4878
0.40	561.75	560.6	564.65	562.33	2.6382	1.6382	4.0955	2.4252

Table D.6.2 Viscosity measurement of HDPE(GA3750) at 135 °C

Concentration ($g.dl^{-1}$)	t_1	t_2	t_3	t_{avg}	η_r	η_{sp}	$\ln \eta_r/C$	η_{sp}/C
solvent	212.35	217.85	209.25	213.15				
0.08	241.97	240	245.06	242.34	1.1370	0.1370	1.7120	1.6045
0.16	287.94	281.44	278.72	282.70	1.3263	0.3263	2.0394	1.7649
0.24	334.34	332.94	336.54	334.61	1.5698	0.5698	2.3742	1.8790
0.4	446.25	436.75	438.13	440.38	2.0660	1.0660	2.6651	1.8141

Table D.6.3 Viscosity measurement of HDPE(G2855) at 135 °C

Concentration ($g.dl^{-1}$)	t_1	t_2	t_3	t_{avg}	η_r	η_{sp}	$\ln \eta_r/C$	η_{sp}/C
solvent	212.35	217.85	209.25	213.15				
0.08	241.16	237.84	238.03	239.01	1.1213	0.1213	1.5165	1.4314
0.16	277.71	277.63	278.87	278.07	1.3046	0.3046	1.9036	1.6617
0.24	331.25	325.43	322.88	326.52	1.5319	0.5319	2.2162	1.7771
0.4	412.53	409.63	407.32	409.83	1.9227	0.9227	2.3068	1.6343

Table D.6.4 Viscosity measurement of HDPE(N3260) at 135 °C

Concentration ($g.dl^{-1}$)	t_1	t_2	t_3	t_{avg}	η_r	η_{sp}	$\ln \eta_r/C$	η_{sp}/C
solvent	212.35	217.85	209.25	213.15				
0.08	232.03	232.87	232.03	232.31	1.0899	0.0899	1.1236	1.0760
0.16	258.37	252.69	258.78	256.61	1.2039	0.2039	1.2744	1.1598
0.24	281.03	275.15	274.34	276.84	1.2988	0.2988	1.2450	1.0893
0.4	320.44	316.56	318.66	318.55	1.4945	0.4945	1.2363	1.0045

Table D.6.5 Viscosity measurement of HDPE(V1160) at 135 °C

Concentration ($g.dl^{-1}$)	t_1	t_2	t_3	t_{avg}	η_r	η_{sp}	$\ln \eta_r/C$	η_{sp}/C
solvent	212.35	217.85	209.25	213.15				
0.08	236.53	237.69	234.09	236.10	1.1077	0.1077	1.3461	1.2784
0.16	266.4	260.4	256.66	261.15	1.2252	0.2252	1.4076	1.2694
0.24	282.81	296.97	284.43	288.07	1.3515	0.3515	1.4645	1.2550
0.4	347.56	338.63	348.34	344.84	1.6178	0.6178	1.5446	1.2027

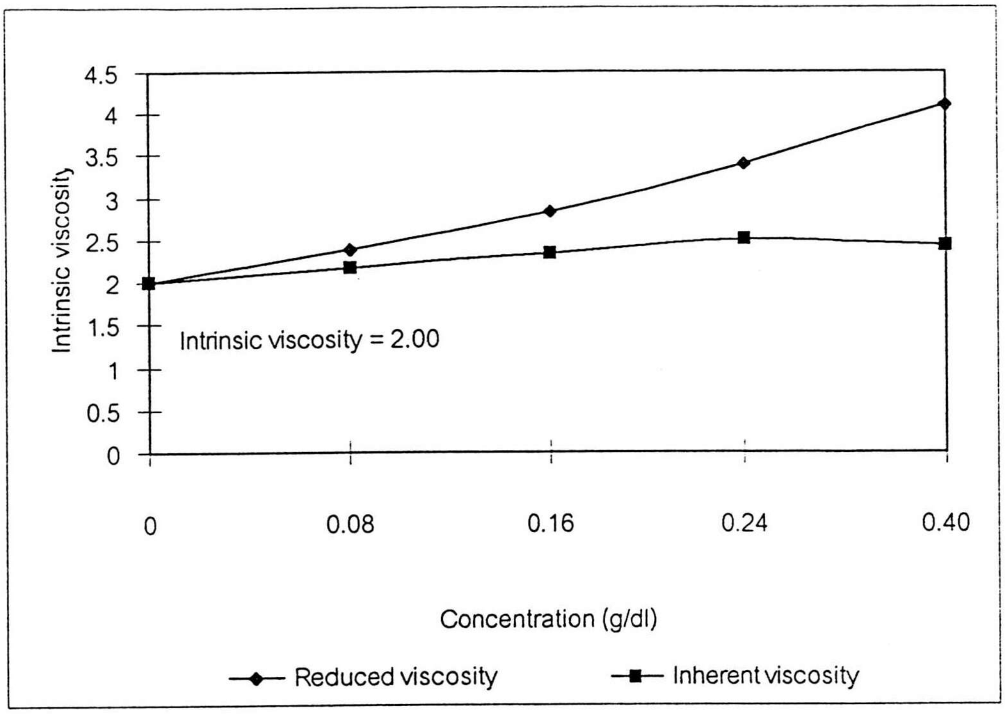


Fig. D.6.1 Intrinsic viscosity of high-density polyethylene (GA3750)

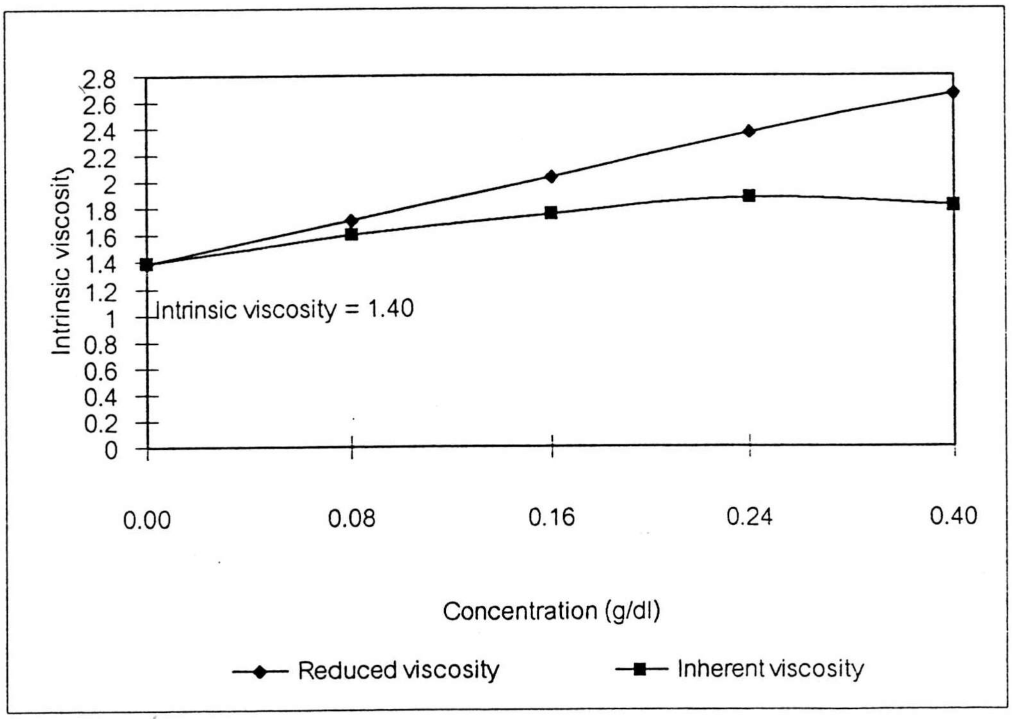


Fig. D.6.2 Intrinsic viscosity of high-density polyethylene (G2855)

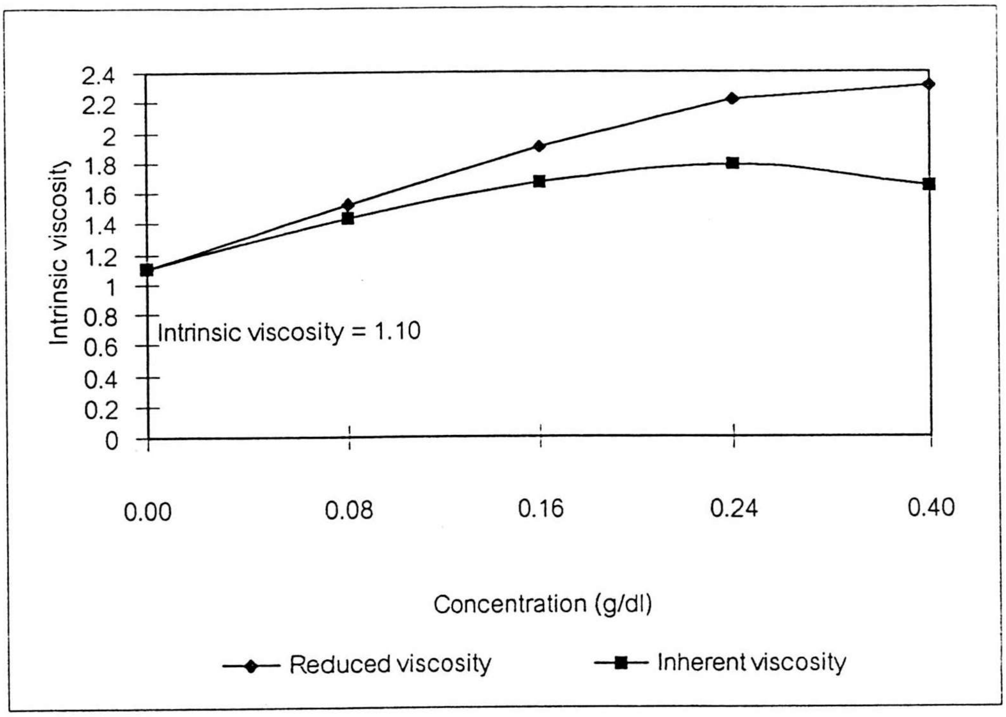


Fig. D.6.3 Intrinsic viscosity of high-density polyethylene (N3260)

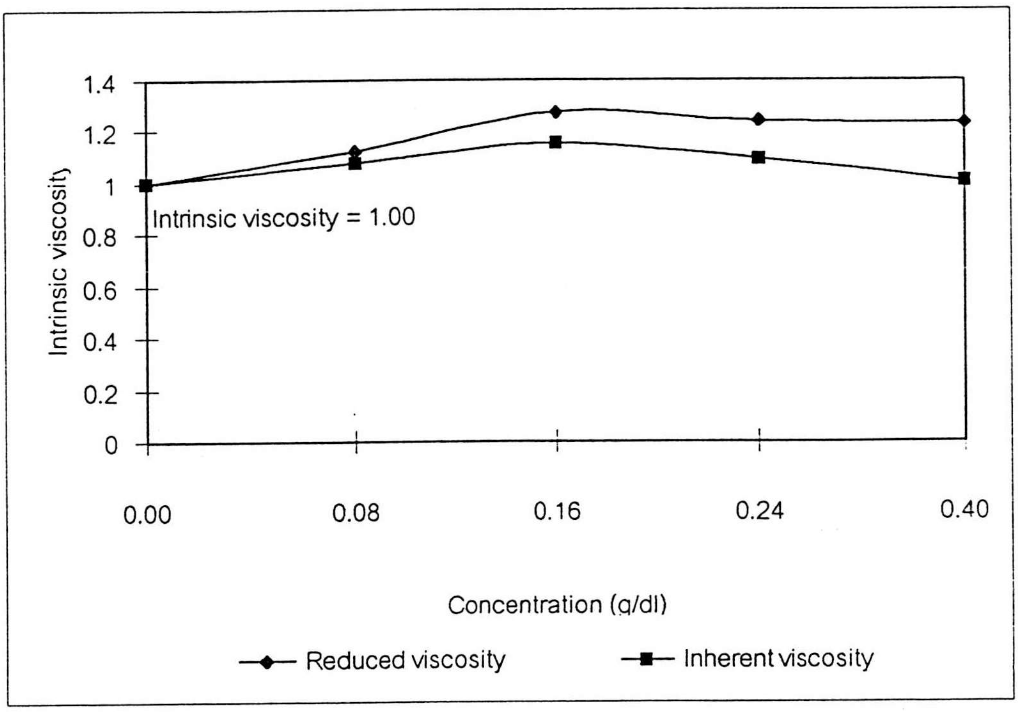


Fig. D.6.4 Intrinsic viscosity of high-density polyethylene (V1160)

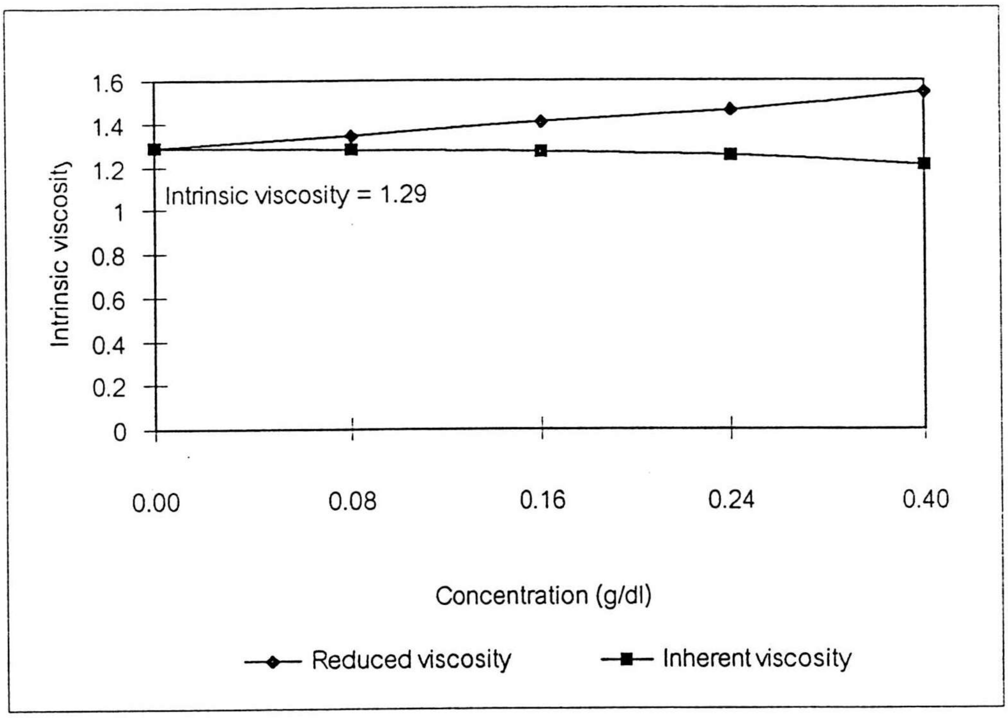


Fig. D.6.5 Intrinsic viscosity of polypropylene (1102H)

APPENDIX E

Crystallinity of HDPE/PP Blends from Differential Scanning Calorimeter

E. 1 Crystallinity of GA3750/1102H (HDPE/PP) Blends

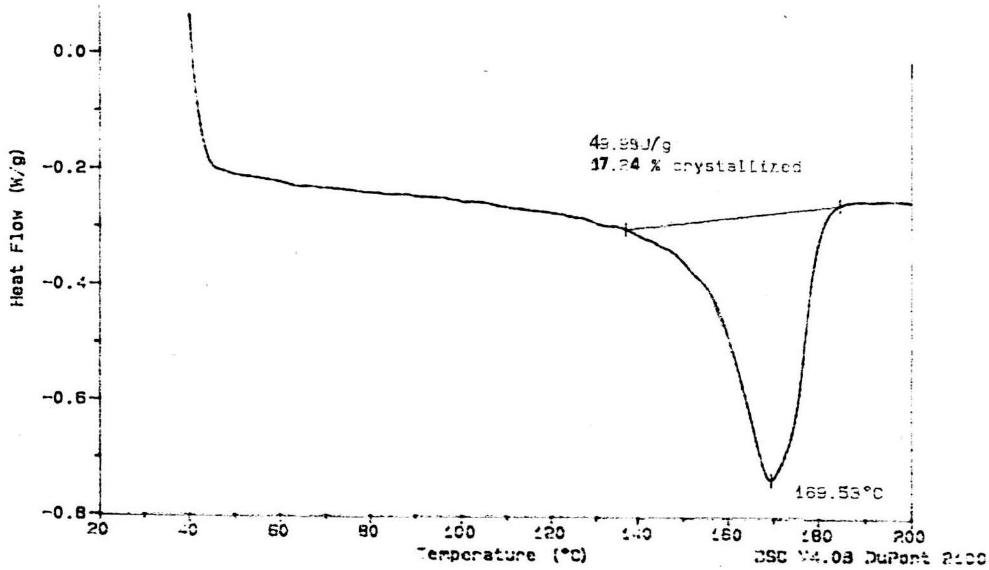


Fig. E.1.1 Thermogram of GA3750/1102H (HDPE/PP) blend at 0:100 composition

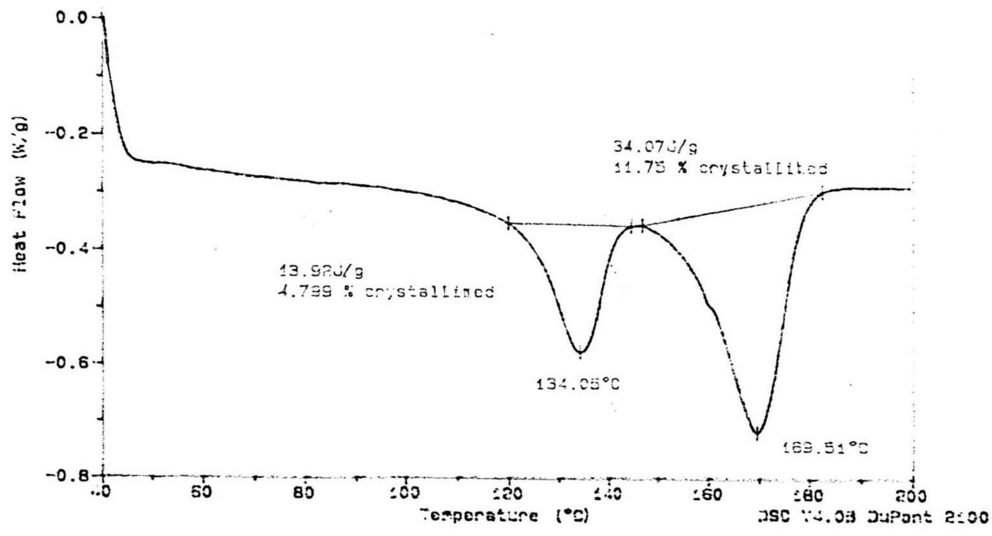


Fig. E.1.2 Thermogram of GA3750/1102H (HDPE/PP) blend at 20:80 composition

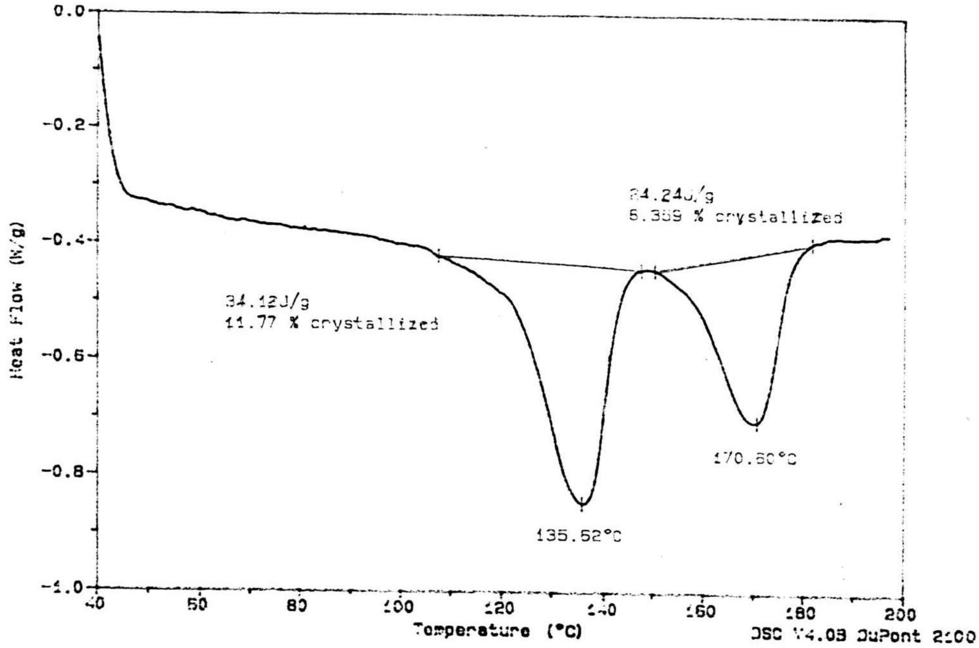


Fig. E.1.3 Thermogram of GA3750/1102H (HDPE/PP) blend at 40:60 composition

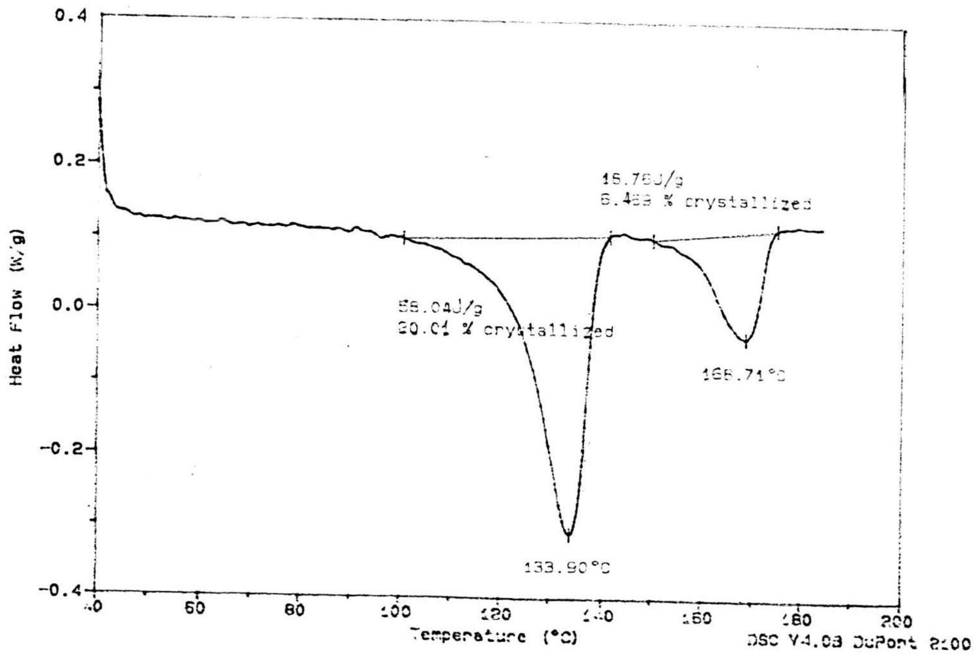


Fig. E.1.4 Thermogram of GA3750/1102H (HDPE/PP) blend at 50:50 composition

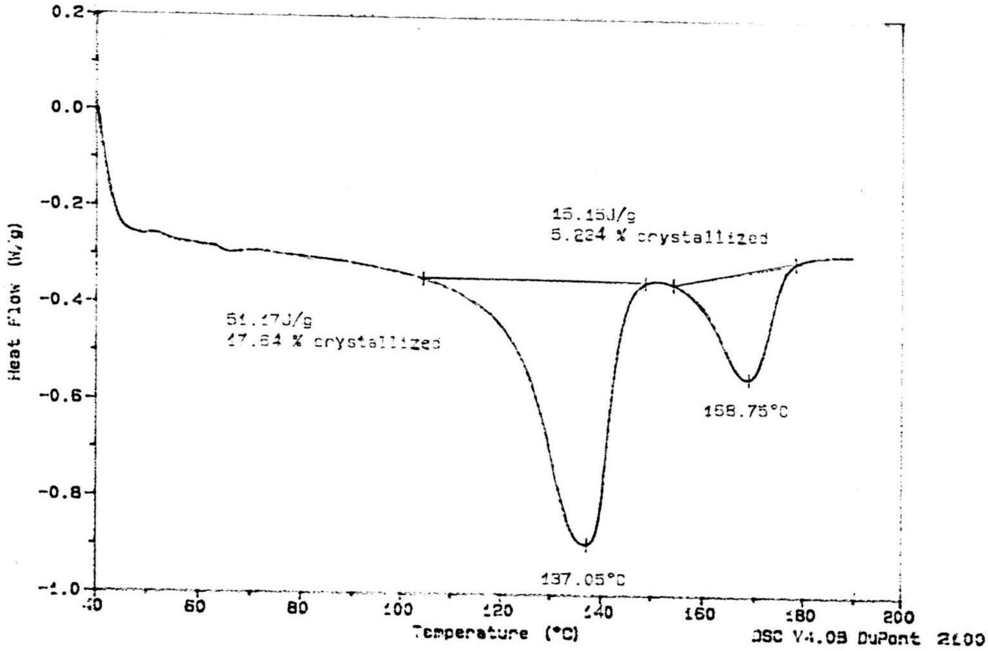


Fig. E.1.5 Thermogram of GA3750/1102H (HDPE/PP) blend at 60:40 composition

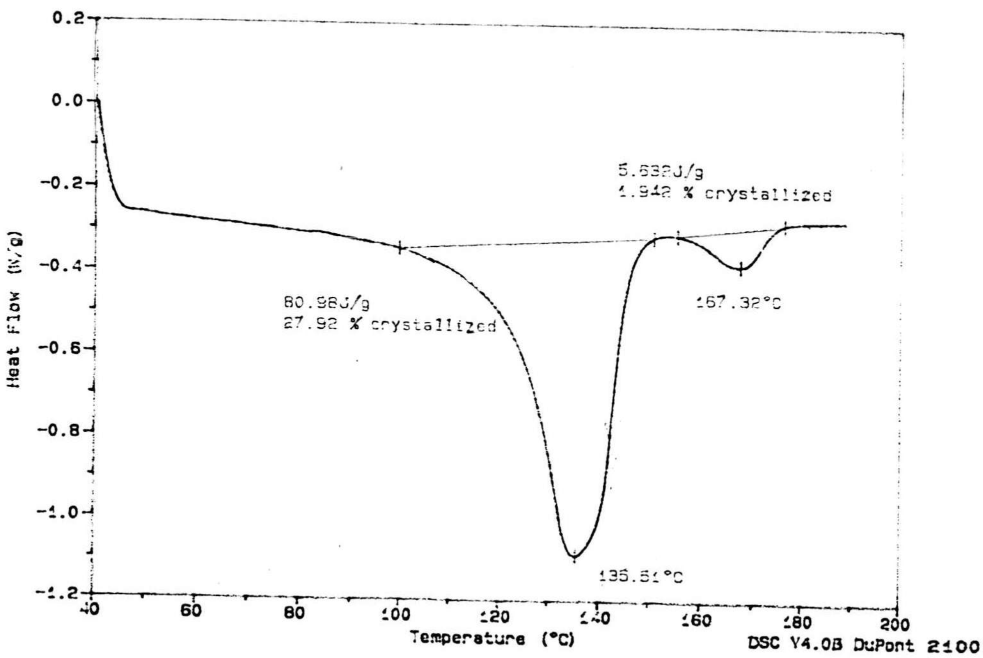


Fig. E.1.6 Thermogram of GA3750/1102H (HDPE/PP) Blend at 80:20 composition

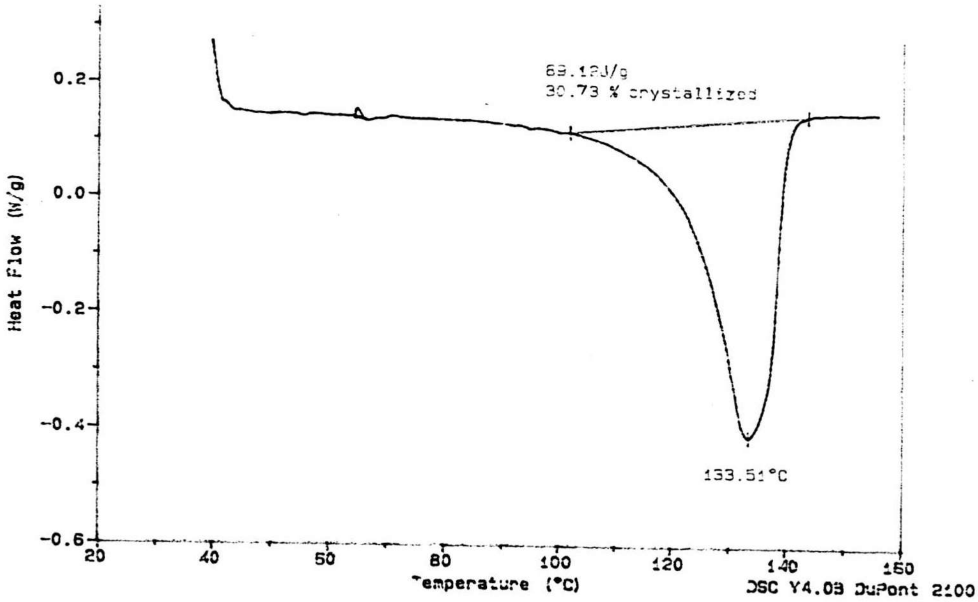


Fig. E.1.7 Thermogram of GA3750/1102H (HDPE/PP) blend at 100:0 composition

E. 2 <u>Crystallinity of G2855/1102H (HDPE/PP) Blends</u>

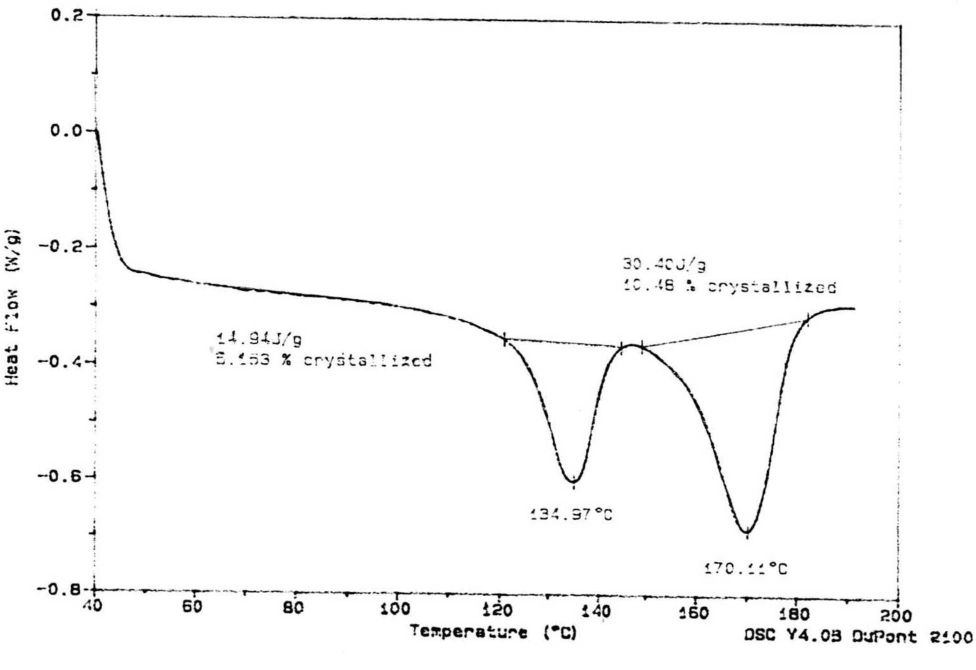


Fig. E.2.1 Thermogram of G2855/1102H (HDPE/PP) blend at 20:80 composition

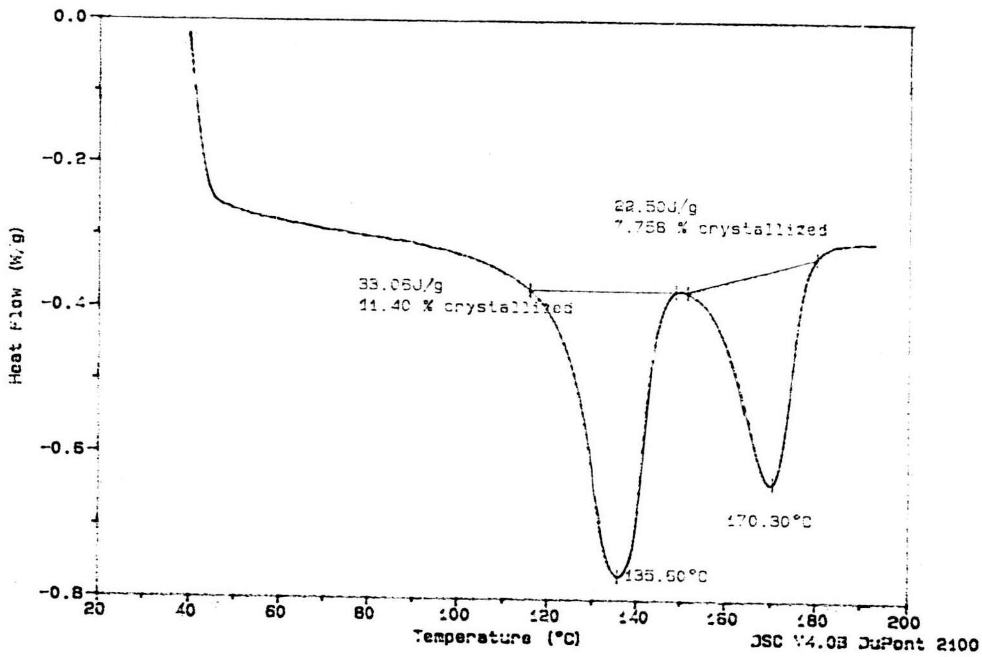


Fig. E.2.2 Thermogram of G2855/1102H (HDPE/PP) blend at 40:60 composition

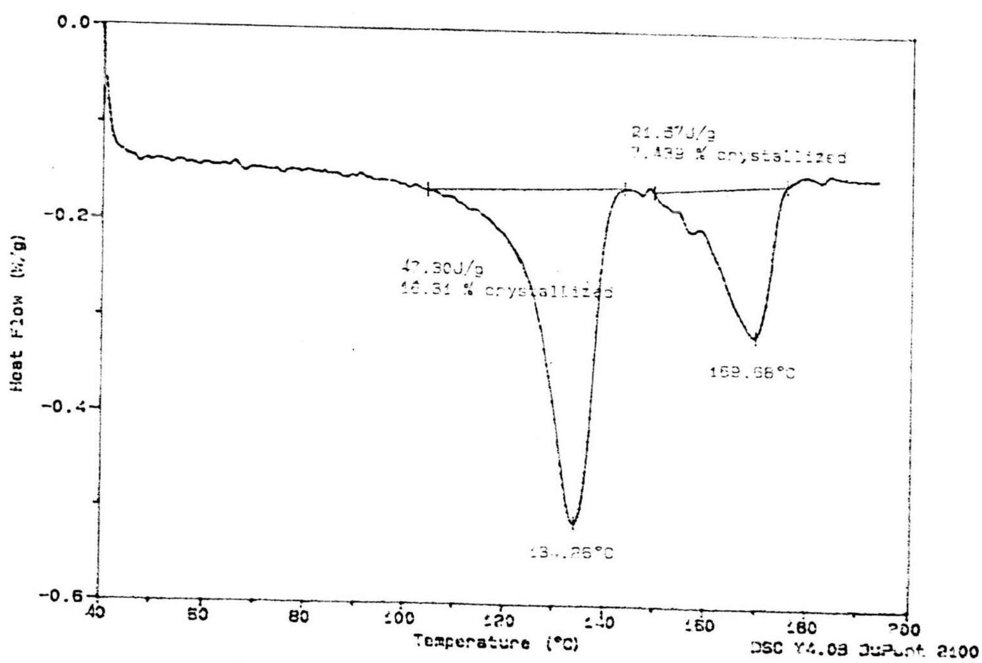


Fig. E.2.3 Thermogram of G2855/1102H (HDPE/PP) blend at 50:50 composition

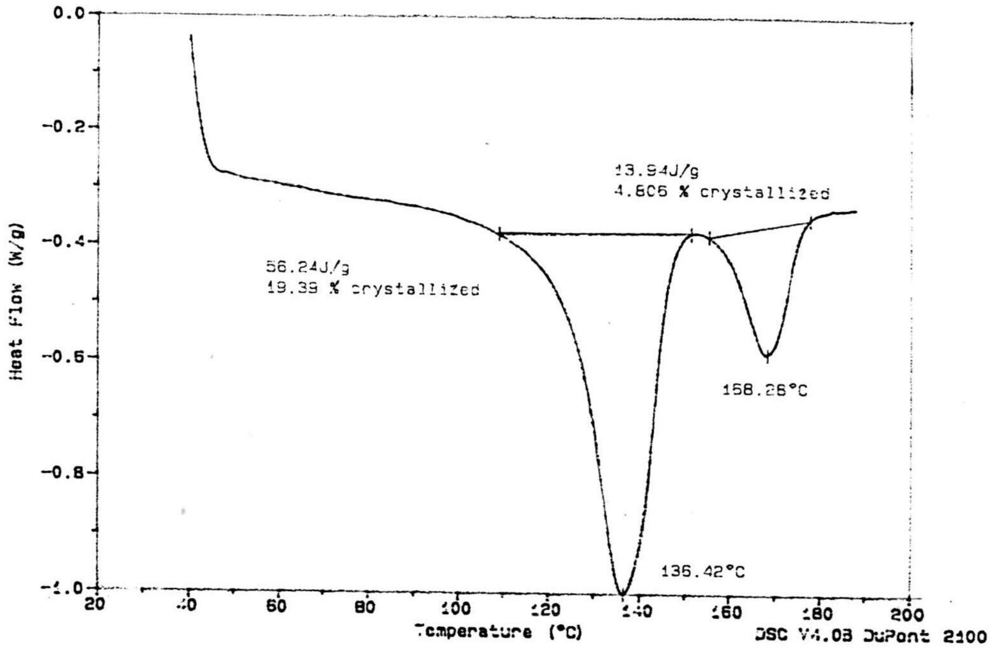


Fig. E.2.4 Thermogram of G2855/1102H (HDPE/PP) blend at 60:40 composition

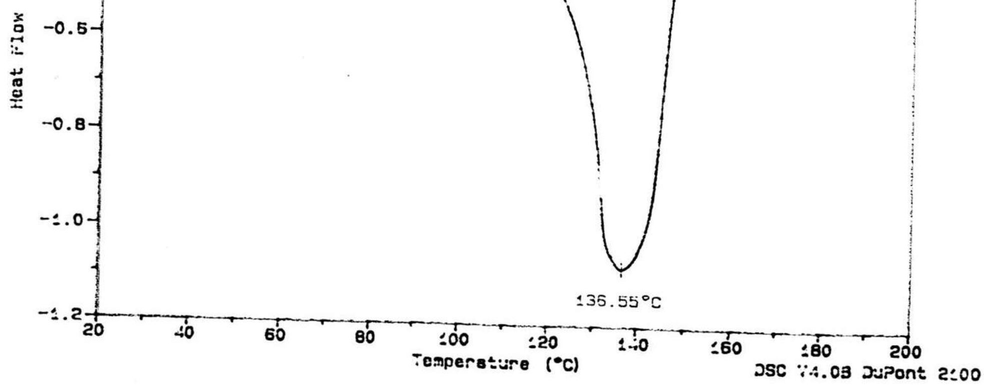


Fig. E.2.5 Thermogram of G2855/1102H (HDPE/PP) blend at 80:20 composition

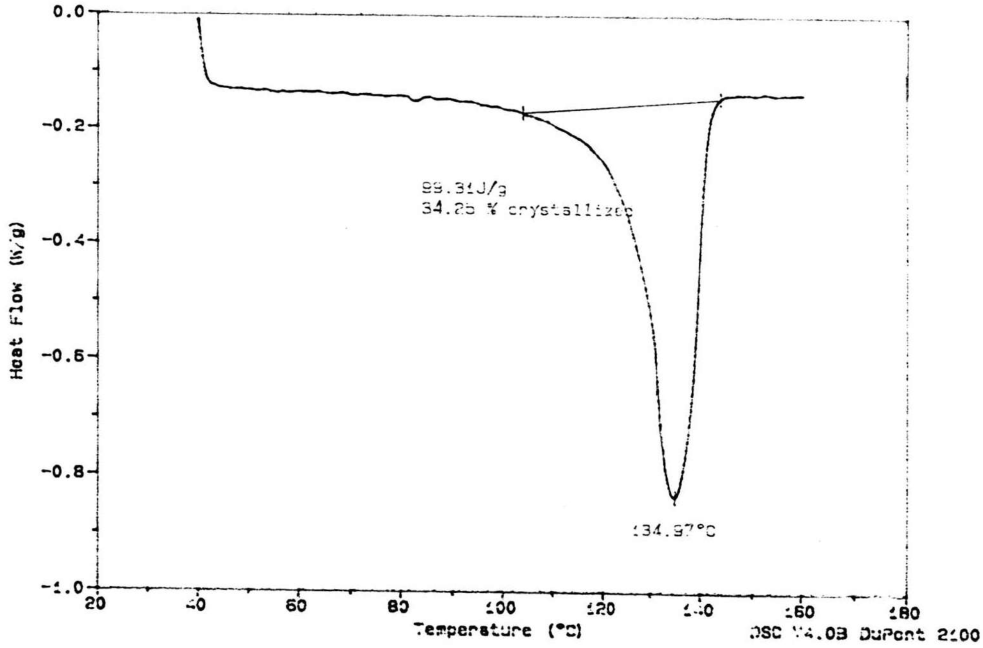


Fig. E.2.6 Thermogram of G2855/1102H (HDPE/PP) blend at 100:0 composition

E. 3 Crystallinity of N3260/1102H (HDPE/PP) Blends

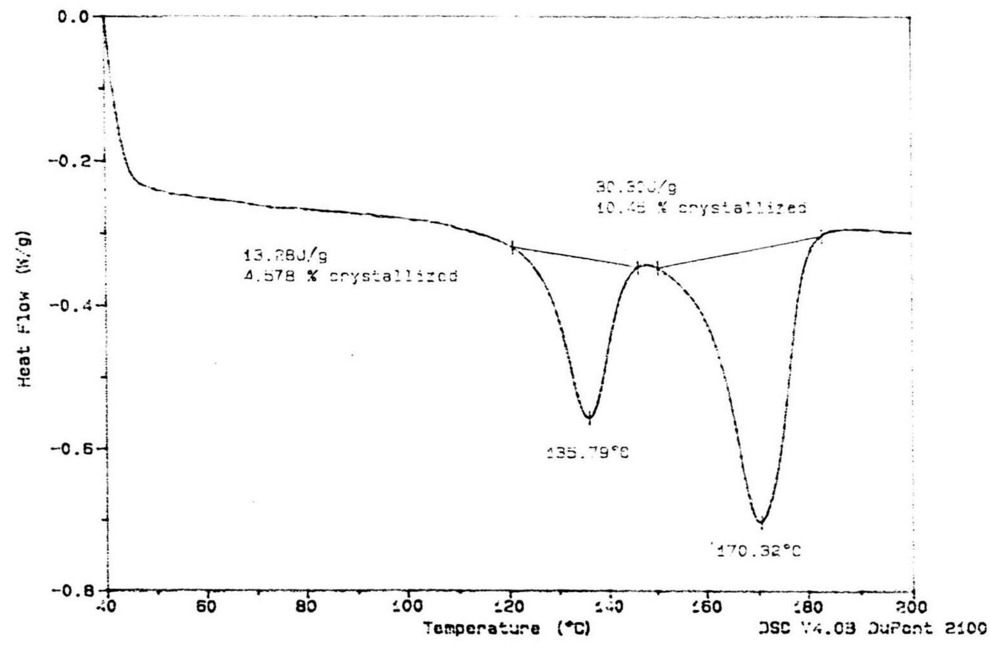


Fig. E.3.1 Thermogram of N3260/1102H (HDPE/PP) blend at 20:80 composition

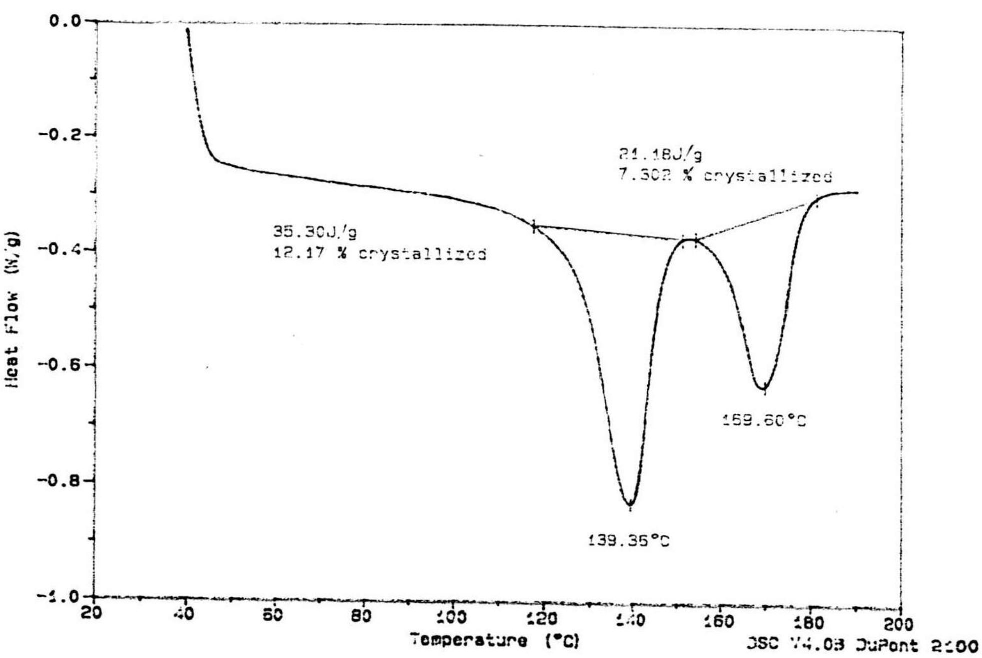


Fig. E.3.2 Thermogram of N3260/1102H (HDPE/PP) blend at 40:60 composition

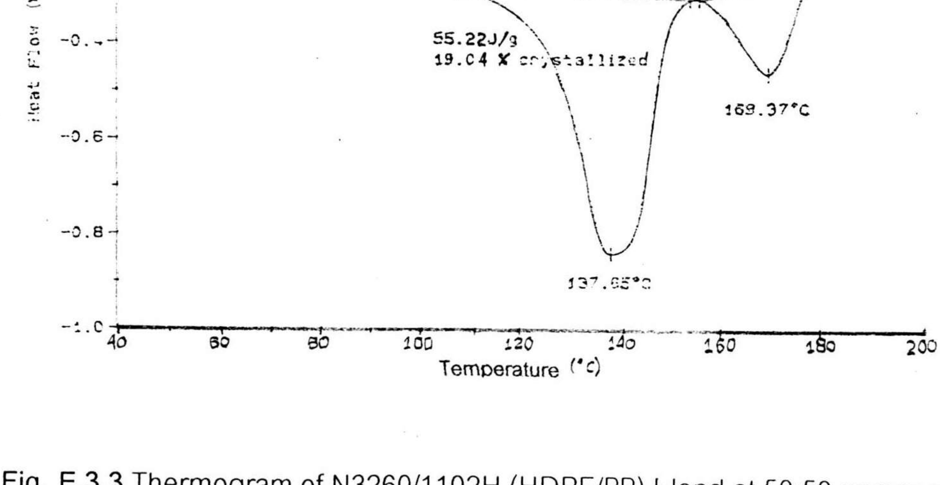


Fig. E.3.3 Thermogram of N3260/1102H (HDPE/PP) blend at 50:50 composition

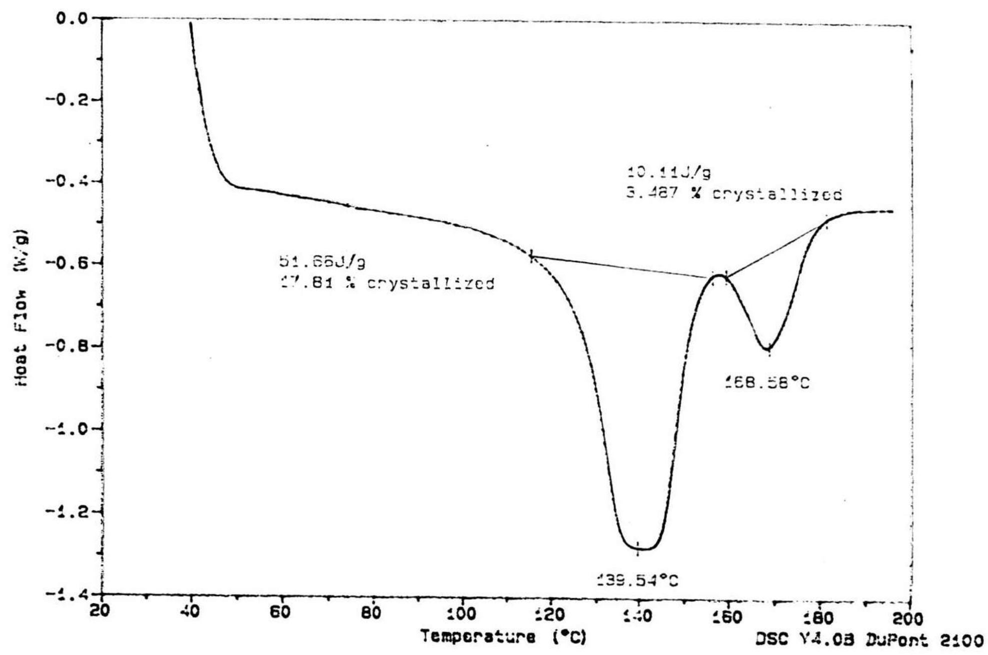


Fig. E.3.4 Thermogram of N3260/1102H (HDPE/PP) blend at 60:40 composition

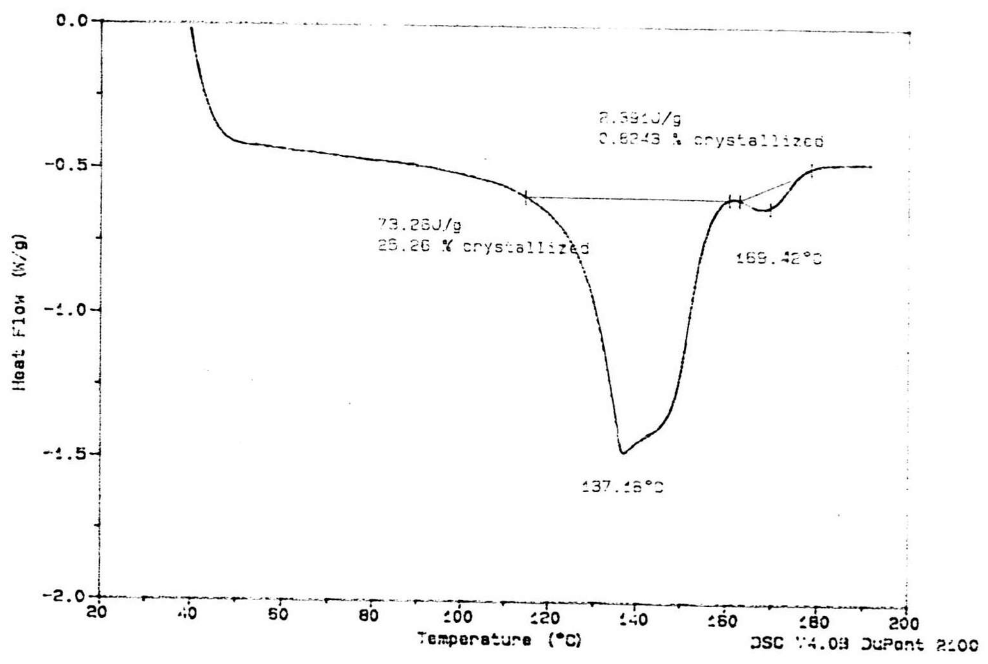


Fig. E.3.5 Thermogram of N3260/1102H (HDPE/PP) blend at 80:20 composition

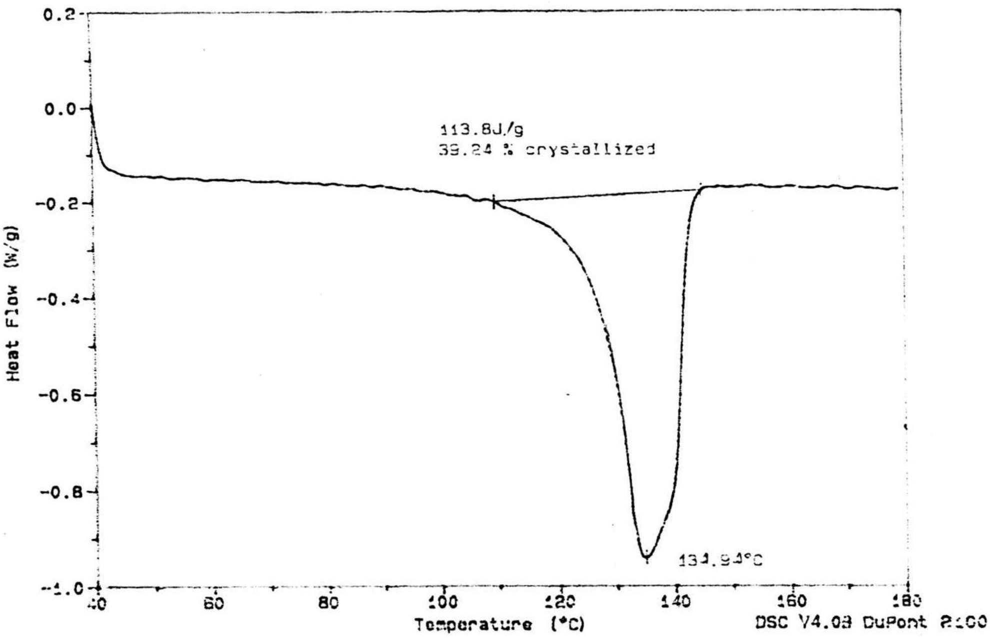


Fig. E.3.6 Thermogram of N3260/1102H (HDPE/PP) blend at 100:0 composition

E. 4 Crystallinity of V1160/1102H (HDPE/PP) Blends

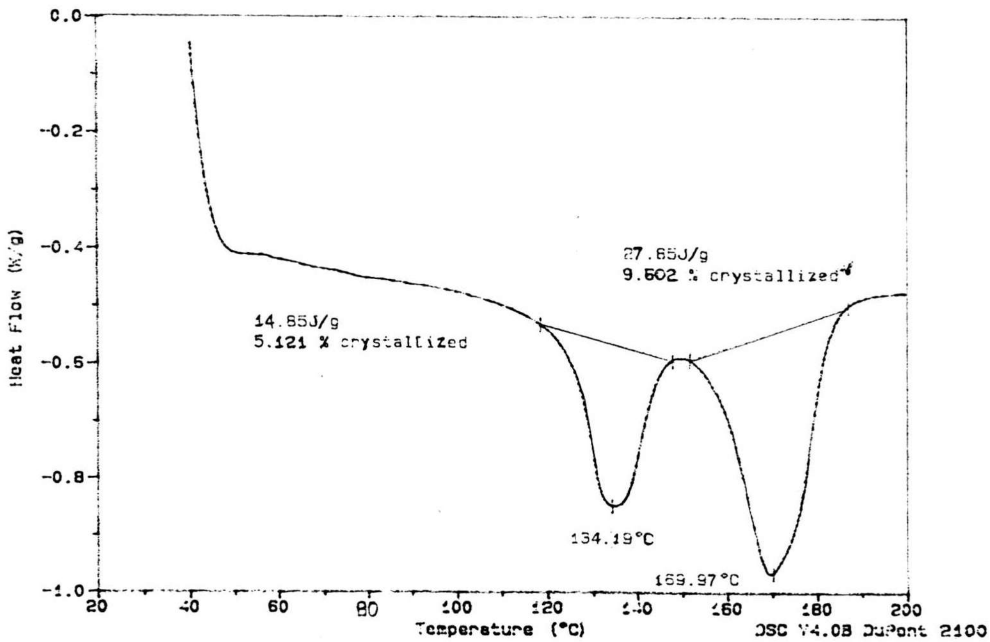


Fig. E.4.1 Thermogram of V1160/1102H (HDPE/PP) blend at 20:80 composition

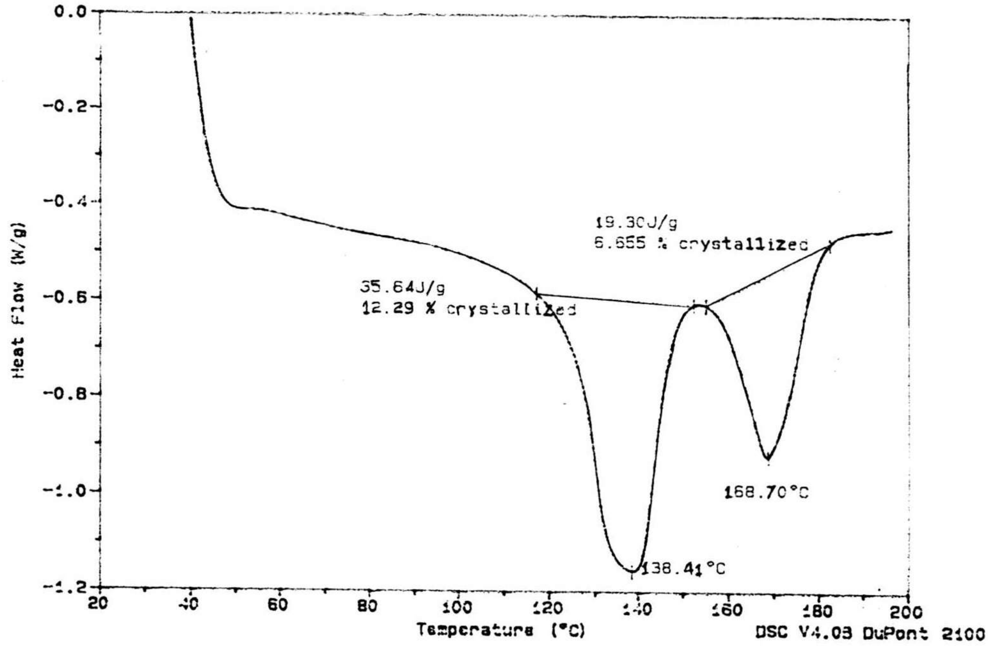


Fig. E.4.2 Thermogram of V1160/1102H (HDPE/PP) blend at 40:60 composition

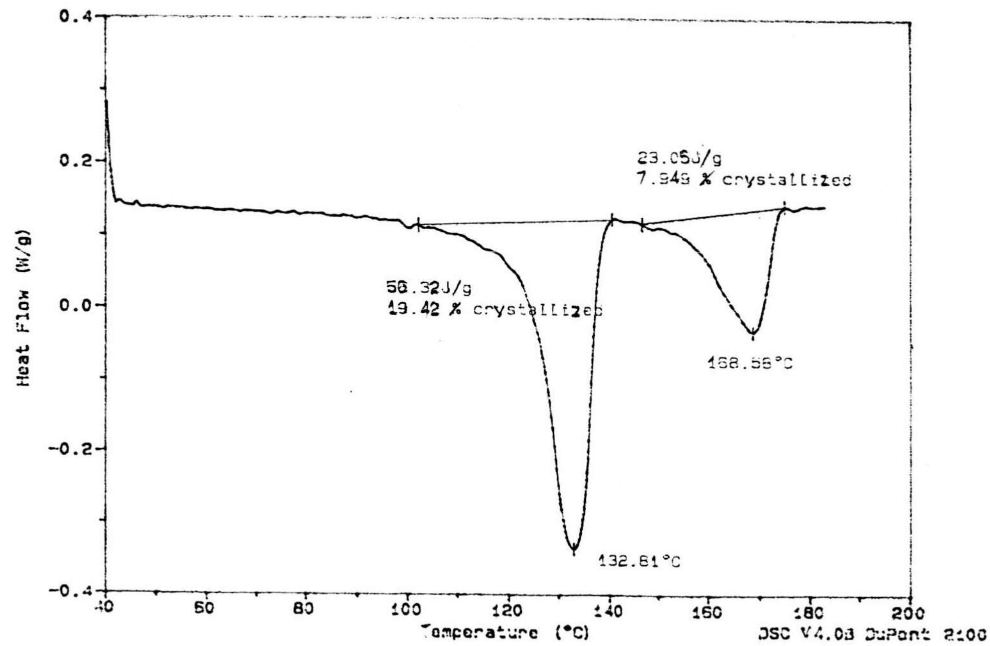


Fig. E.4.3 Thermogram of V1160/1102H (HDPE/PP) blend at 50:50 composition

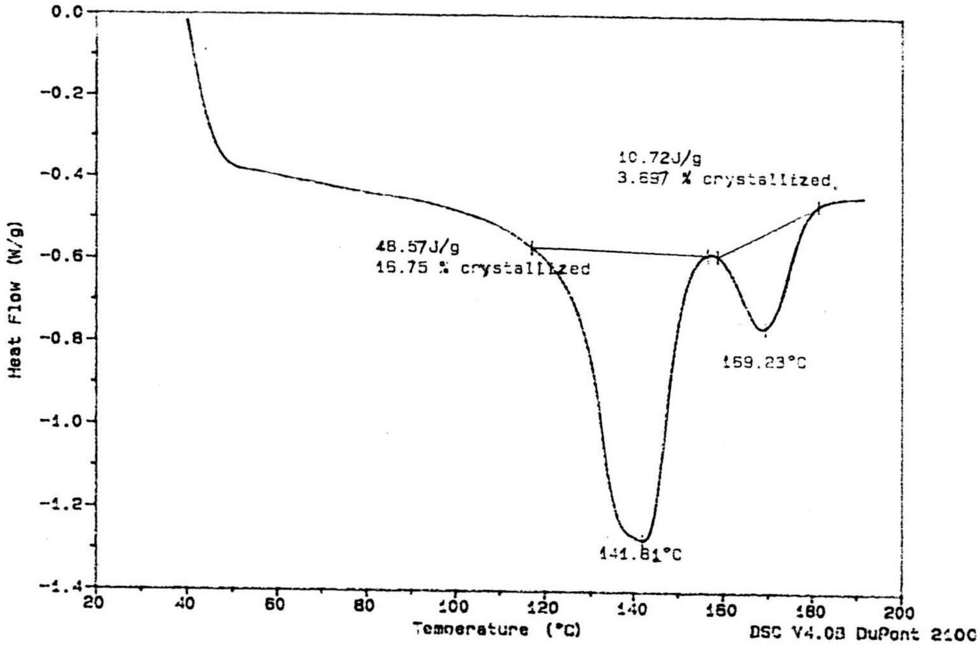


Fig. E.4.4 Thermogram of V1160/1102H (HDPE/PP) Blend at 60:40 composition

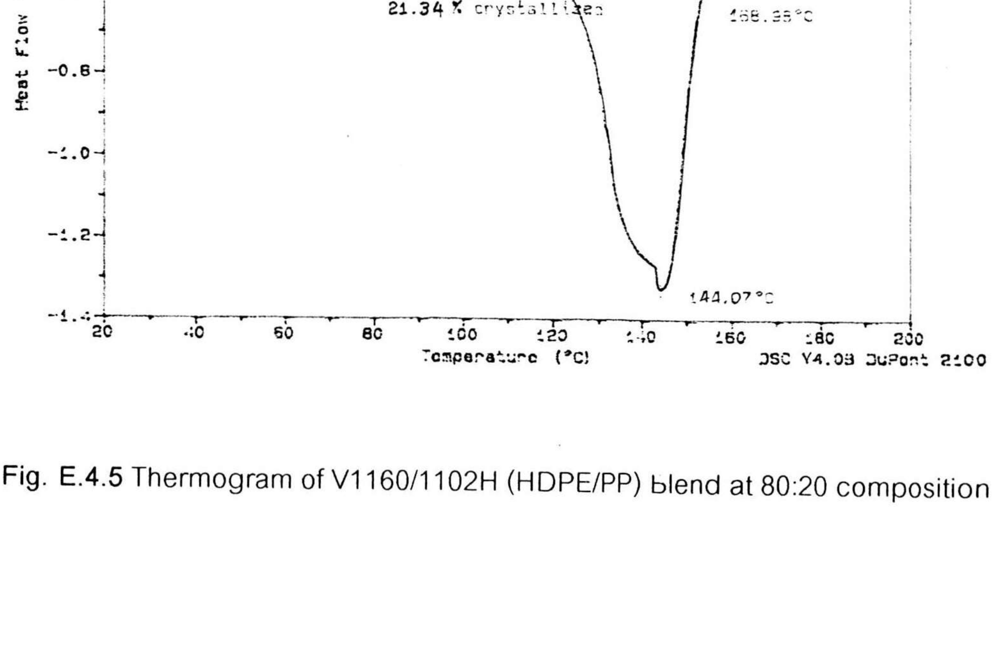


Fig. E.4.5 Thermogram of V1160/1102H (HDPE/PP) blend at 80:20 composition

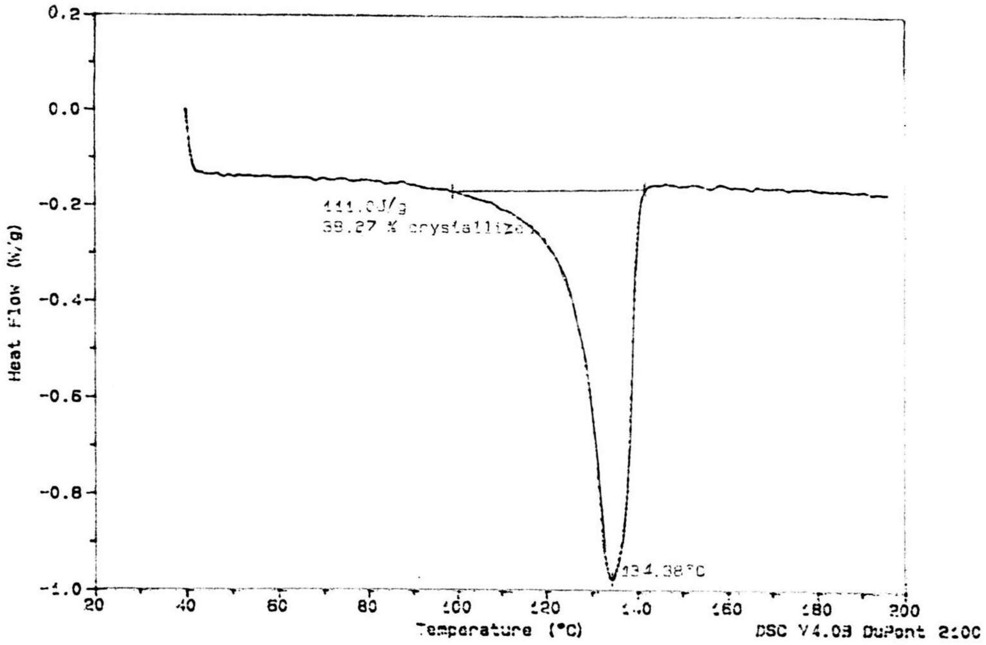


Fig. E.4.6 Thermogram of V1160/1102H (HDPE/PP) blend at 100:0 composition

VITA

Mr.Sirisart Ouajai was born on March 25, 1972 in Prachinburi. He received a Bachelor's degree of Science in Industrial Chemistry from the Faculty of Applied Science, King Mongkute's Institutes of Technology North Bangkok in 1994 and he has been graduate student in the Multidisciplinary Program of Petrochemistry-Polymer, Graduate School, Chulalongkorn University in 1995.