REFFERNCES

Alexandre, M. and Dubois, P. (2000) Polymer-layered silicate nanocomposites: preparation, properties and uses of a new class of materials. Materials Science and Engineering Review, 28, 1–63.

Ambrogi, V., Fardella, G., Grandolini, G. and Perioli, L. (2001) Intercalation compounds of hydrotalcitelike anionic clays with anti-inflammatory agents- Intercalation an in vitro release of ibu profen. International journal of pharmaceutics, 220, 23–32.

Anastasiadis, S.H., Karatosos, K. and Vlachos, G. (2000) Nanoscopic-Confinement Effects on Local Dynamics. Physical Review Letters, 84, 915–918.

Antonietti, M. (2001) Surfactants for novel templating applications. Current Opinion in Colloid & Interface Science, 6, 244–248.

Arco, M.D, Malet, P., Trujillano, R. and Rives, V. (1999) Synthesis and characterization of hydrotalcites containing Ni(II) and Fe(III) and their calcination products. Chemistry of Materials, 11, 624–633.

Auerbach, S.M., Carrado, K., Dutta, P.K. (Eds.). (2004) Handbook of Layered Materials. New York: Marcel Dekker.

Avella, M, Cosco, S. and Errico, M.E. (2005) Preparation of isotactic polypropylene/organoclay nanocomposites by solution mixing methodology: Structure and properties relationships. Macromolecular Symposia, 228, 147–154.

Balazs, A.C., Singh, C. and Zhulina, E. (1998) Modeling the interactions between polymers and clay surfaces through self-consistent field theory. Macromolecules, 31, 8370–8381.

Bansal, A., Yang, H., Li, C.Z., Cho, K.W., Benicewicz, B.C., Kumar, S.K. and Schadler, L.S. (2005) Quantitative equivalence between polymer nanocomposites and thin polymer films. Nature Materials, 4, 693–698.

Becker, O., Varley, R.J., Simon, G.P. (2004) Thermal stability and water uptake of high performance epoxy layered silicate nanocomposites. European Polymer Journal, 40, 187–95.

Berti, C., Fiorini, M. and Sisti, L. (2009) Synthesis of poly(butylene terephtahlate) nanocomposites using anionic clays. European Polymer Journal, 45, 70–78.

Bertini, F., Canetti, M., Audisio, G., Costa, G. and Falqui, L. (2006) Characterization and thermal degradation of polypropylene-montmorillonite nanocomposites. Polymer Degradation and Stability, 91, 600–605.

Beyer, G. (2002) Nanocomposites: a new class of flame retardants for polymers. Plastic Additives Compound, 4(10), 22–27.

Biasci, L., Aglietto, A., Ruggeri, G. and Ciardelli, F. (1994) Functionalization of montmorillonite by methyl methacrylate polymers containing side-chain ammonium cations. Polymer, 35, 3296–3304.

Boehm, H.P., Steinle, J. and Vieweger, C. (1977) $[Zn_2Cr(Oh)_6]X{\cdot}2H_2O$, New Layer Compounds Capable of Anion Exchange and Intracrystalline Swelling. Angewandte Chemie International Edition in English, 16, 265-266.

Bonczek, J.L., Harris, W.G. and Nkedi-Kizza, P. (2002) Monolayer to bilayer transitional arrangements of hexadecyltrimethylammonium on Na-montmorillonite. Clays and Clay Minerals. 50, 11–17.

Borsig, E., Pavalikova, S., Thomann, R., Reichert, P., Mulhaupt, R. and Marcincin, A. (2002). Fiber Spinning from Poly(propylene)-Organoclay Nanocomposite. Journal of Applied Polymer Science, 89, 604–611.

Brindley, G.W. and Brown, D. (1980) Crystal structures of clay minerals and their X-ray identification. Mineralogical Society, 170–178.

Brindley, G.W. and Kikkawa, S. (1980) Thermal behavior of hydrotalcite and of anion-exchanged forms of hydrotalcite. Clays and Clay Minerals, 28, 87–91.

Brown, G. (1972) The X-ray identification and crystal structures of clay minerals, 2nd Ed., Mineralogical Society, 192–200.

Brown, G. and Gastuche, M.C. (1967) Mixed magnesium aluminum hydroxides, II structural chemistry of synthetic hydroxyl-carbonates and related minerals and compound. Clay Minerals, 7, 193–201.

Bryson, J.A. (1981) George Godwin Ltd., London, 1981.

Bu, H.S., Cheng, S.Z.D. and Wunderlich, B. (1988) Addendum to the thermal properties of polypropylene. Makromolekulare Chemie-Rapid Communications, 9, 75–77.

Buniak, G.A., Schreiner, W.H., Mattoso, N. and Wypych, F. (2002) Preparation of a new nanocomposite of $Al_{0.33}Mg_{0.67}(OH)_2(C_{12}H_{25}SO_4)_{0.33}$ and poly(ethyleneoxide). Langmuir, 18, 5967–5970.

Carlino, S. and Hudson, M.J. (1995) Thermal intercalation of layered double hydroxides: capric acid into an Mg-Al LDH. Journal of Materials Chemistry, 5, 1433–1442.

Carlino, S., Hudson, M.J., Husain, S.W. and Knowles, J.A. (1996) The reaction of molten phenylphosphonic acid with a layered double hydroxide and its calcined oxide. Solid State Ionics, 84, 117–29.

Carlino, S. and Hudson, M.J. (1997) The intercalation of carboxylic acids into layered double hydroxides: a critical evaluation and review of the different methods. Solid State Ionics, 98, 73–84.

Causin, V., Marea, C., Marigo, A. and Ferrara, G. (2005) Assessing organo-clay dispersion in polymer layered silicate nanocomposites: a SAXS approach. Polymer, 46, 9533–9537.

Cavani, F. and Trifiro. F. (1991) Hydrotalcite-type anionic clays: preparation, properties and applications. Catalysis Today, 11, 173–301.

Chen, W. and Qu, B. (2004) LLDPE/ZnAl LDH-exfoliated nanocomposites: effects of nanolayers on thermal and mechanical properties. Journal of Materials Chemistry, 14, 1705–1710.

Chen, W. and Qu., B. (2003) Structural characteristics and thermal properties of PE-g-MA/MgAl-LDH exfoliation nanocomposites synthesized by solution intercalation. Chemisty of Materials, 15, 3208–3213.

Chen, W., Feng, L. and Qu, B. (2004) Preparation of nanocomposites by exfoliation of ZnAl layered double hydroxides in nonpolar LLDPE solution. Chemisty of Materials, 16, 368–370.

Chen, D.Z., Yang, H., He, P. and Zhang, W. (2005) Rheological and extrusion behavior of intercalated high-impact polystyrene/organomontmorillonite nanocomposites. Composites Science and Technology, 65, 1593–1600.

Cheung, K., M., He J. D., Yang S. M. and Qi Z. (2002) Thermal Stability and Crystallization Kinetic of Isotactic Polypropylene/Organomontmorillonite Nanocomposites. Journal of Applied Polymer Science, 89, 3404–3415.

Chibwe, K. and Jones, W. (1989) Intercalation of organic and inorganic anions into layered double hydroxides. Journal of the Chemical Society, Chemical Communications, 926–927.

Chin, I.J., Albrecht, T.T., Kim, H.C., Russell, T.P., and Wang, J. (2001) On exfoliation of montmorillonite in epoxy. Polymer, 42, 5947–5952.

Ciardelli, F., Coiai, S., Passaglia, E., Pucci, A. and Ruggeri, G. (2008) Nanocomposites based on polyolefins and functional thermoplastic materials. Polymer International, 57, 805–836.

Cho, Y.G. and Kamal, M.R. (2004) Estimation of stress for separation of two platelets. Polymer Engineering and Science, 44, 1187–1195.

Choi, Y.S., Choi M.H. (2001) Synthesis of Exfoliated PMMA/Na-MMT Nanocomposite via Soap-Free Emulsion Polymerization. Macromolacule, 34, 8978–8985.

Coiai, S., Passaglia, E., Hermann, A., Augier, S., Pratelli, D. and Streller, R.C. (2009) The influence of the compatibilizer on the morphology and thermal properties of polypropylene-layered double hydroxide composites. Polymer Composites, 31, 744–754.

Constantino, V.R.L. and Pinnavaia, T.J. (1995) Basic Properties of $Mg_{1-x}^{2+}Al_x^{3+}$ Layered Double Hydroxides Intercalated by Carbonate, Hydroxide, Chloride, and Sulfate Anions. Inorganic Chemistry, 34, 883–892.

Costa, A.S. Imae, T., Takagi, K. and Kikuta. K. (2004) Intercalation of dendrimers in the interlayer of hydrotalcite clay sheets. Progress in Colloidal Polymer Science, 128, 113–119.

Costa, F.R., Abdel-Goad, M., Wagenknecht, U. and Heinrich, G. (2005) Nanocomposites based on polyethylene and Mg-Al layered double hydroxide, I. Synthesis and characterization. Polymer, 46, 4447–4453.

Costa, F.R., Leuteritz, A. and Wagenknecht, U. (2008) Intercalation of Mg–Al layered double hydroxide by anionic surfactants: Preparation and characterization. Applied Clay Science, 38, 153–164.

Costa, F.R., Wagenknecht, U., Jehnichen, D., Goad, M.A. and Heinrich, G. (2006) Nanocomposites based on polyethylene and Mg-Al layered double hydroxide. Part II. Rheological characterization. Polymer, 47, 1649–1660.

Costa, F.R., Wagenknecht, U. and Heinrich, G. (2007) LDPE/Mg-Al double hydroxide nanocomposite: Thermal and flammability properties. Polymer Degradation and Stability, 92, 1813–1823.

Costa, F.R., Satapathy, B.K., Wagenknecht, U., Weidisch, R. and Heinrich, G. (2006) Morphology and fracture behaviour of polyethylene/MgAl layered double hydroxide (LDH) nanocomposites. European Polymer Journal, 42, 2140–2152.

Costantino, U., Gallipoli, A., Nocchetti, M., Camino, G., Bellucci, F. and Frache, A. (2005) New nanocomposites constituted of polyethylene and organically modified ZnAl-hydrotalcites. Polymer Degradation and Stability, 90, 586–590.

Costantino, U., Bugatti, V., Gorrasi, G., Montanari, F., Nocchetti, M., Tammaro, L. and Vittoria, V. (2009) New polymeric composites based on poly(ε-caprolactone) and layered double hydroxides containing antimicrobial species. ACS Applied Materials & Interfaces, 1, 668–677.

Crepaldi, E.L., Pavan, P.C. and Valim, J.B. (2000) Anion exchange in layered double hydroxides by surfactant salt formation. Journal of Materials Chemistry, 10, 1337–1343.

Dangtungee, R., Yun, J. and Supaphol, P. (2005) Melt rheology and extrudate swell of calcium carbonate nanoparticle-filled isotactic polypropylene. Polymer Testing, 24, 2–11.

Dennis, H.R., Hunter, D.L., Chang, D., Kim, S., White, J.L., Cho, J.W., and Paul, D.R. (2001) Effect of melt processing conditions on the extent of exfoliation in organoclay-based nanocomposites. Polymer, 42, 9513–9522.

Ding, C., Jia, D., He, H., Guo, B., and Hong, H. (2004) How organo-montmorillonite truly affects the structure and properties of polypropylene. Polymer Testing, 24, 94–100.

Ding, P. and Q, B. (2006) Synthesis of exfoliated PP/LDH nanocomposites via melt-intercalation: Structure, thermal properties, and photo-oxidative behavior in comparison with pp/mmt nanocomposites. Polymer Engineering and Science, 10, 1153–1159.

Ding, Y., Guo, C., Dong, J., and Wang, Z. (2006) Novel organic modification of montmorillonite in hydrocarbon solvent using ionic liquid-type surfactant for the preparation of polyolefin-clay nanocomposites. Journal of Applied Polymer Science, 102, 4314–4320.

Du, L. and Qu, B. (2006) Structural characterization and thermal oxidation properties of LLDPE/MgAl-LDH nanocomposites. Journal of Material Chemistry, 16, 1549–1554.

Duquesne, S., Jama, C., Le Bras, M., Delobel, R., Recourt, P. and Gloaguen, J.M. (2003) Elaboration of EVA-nanoclay systems - Characterization, thermal behaviour and fire performance. Composites Science and Technology, 63, 1141–1148.

Earley, J.W., Osthaus, B.B., and Milne, I.H. (1953) Purification and properties of montmorillonite. American Mineralogist, 38, 707–724.

Elmahdy, M.M., Chrissopoulou, K., Afratis, A., Floudas, G. and Anastasiadis, S.H. (2006) Effect of confinement on polymer segmental motion and ion mobility in PEO/layered silicate nanocomposites. Macromolecules, 39, 5170–5173.

Fan, Q. and Samuel, C. U. (2004) Dyeable polypropylene via nanotechnology. National

Textile Center Research Briefs-Chemistry Competency.

Fornes, T.D., Hunter, D.L. and Paul, D.R. (2004) Nylon-6 Nanocomposites from Alkylammonium-Modified Clay: The Role of Alkyl Tails on Exfoliation. Macromolecules, 37, 1793–1798.

Fornes, T.D., Yoon, P.J., Keskkula, H. and Paul, D.R. (2001) Nylon 6 nanocomposites: the effect of matrix molecular weight. Polymer, 42, 9929–9940.

Fornes, T.D., Yoon, P.J., Hunter, D.L., Keskkula, H. and Paul, D.R. (2002) Effect of organoclay structureon nylon 6 nanocomposite morphology and properties. Polymer, 43, 5915–5933.

Fuda, K., Sudo, N., Kawai, S. and Matsunaga, T. (1993) Preparation of zn/ga-layered double hydroxide and its thermal decomposition behavior. Chemistry Letters, 22, 777–780.

Fukushima, Y. and Inagaki, S. (1987) Synthesis of an intercalated compound of montmorillonite and 6-polyamide. Journal of Inclusion Phenomena, 5, 473–482.

Galgali, G., S. Agarwal, S. and Lele, A. (2004) Effect of clay orientation on the tensile modulus of polypropylene–nanoclay composites. Polymer, 45, 6059-6069.

Galgali, G., Ramesh, C. and Lele, A. (2001) A rheological study on the kinetics of hybrid formation in polypropylene nanocomposites. Macromolecules, 34, 852–858.

Galli, P. and Vecellio, G. (2003) Polyolefins: The Most Promising Large-Volume Materials for the 21st Century. Journal of Polymer Science, Part A: Polymer Chemistry, 42, 396–415.

Garcia-Lopez D., Picazo O., Merino J. C. and Pastor J. M. (2003). Propypropylene-clay nanocomposites: effect of compatibilizing agents on clay dispersion. European Polymer Journal, 39, 945–950.

Giannelis E.P. (1996). Polymer layered silicate nanocomposites. Advanced Materials, 8, 29–35.

Giannelis, E.P., Krishnamoorti, R.K. and Manias, E. (1998) Polymer-silicate nanocomposites: model systems for confined polymers and polymer brushes, in Polymers in Confined Environments. Advances in Polymer Science, 138, 107–148.

Giannelis, E.P., Krishnamoorti, R. and Manias, E. (1999) Polymer-silicate nanocomposites: Model systems for confined polymers and polymer brushes. Advances in Polymer Science, 138, 107–147.

Gilman, J.W. (1999) Flammability and thermal stability studies of polymer layered-silicate-clay/ nanocomposites. Applied Clay Science, 15, 31–49.

Gu, S.Y., Ren, J. and Wan, Q.F. (2004) Rheology of Poly (propylene)/Clay Nanocomposites. Journal of Applied Polymer Science, 91, 2427–2434.

Hackett, E., Manias, E. and Giannelis, E. P. (1998) Molecular dynamics simulations of organically modified layered silicates. Journal of Chemical Physics, 108, 7410–7415.

Hamaker, H.C. (1937) The London-van der Waals attraction between spherical particles. Physica, 4, 1058–1072.

Hambir, S., Bulakh, N., Kodgire, P., Kalgaonkar, R. and Jog, J.P. (2001) PP/clay nanocomposites: A study of crystallization and dynamic mechanical behavior. Journal of Polymer Science Part B: Polymer Physics, 39, 446–450.

Harrats, C. and Groeninckx, G. (2008) Features, Questions and Future Challenges in Layered Silicates Clay Nanocomposites with Semicrystalline Polymer Matrices. Macromolecular Rapid Communications, 29, 14–26.

Hasegawa, N., Kawasumi, M., Kato, M., Usuki, A. and Okada, A. (1998) Preparation and mechanical properties of polypropylene–clay hybrids using a maleic anhydride modified polypropylene oligomer. Journal of Applied Polymer Science, 67, 87–92.

Hasegawa, N., Okamoto, H., Kawasumi, M., Kato, M., Tsukigase, A. and Usuki, A. (2000) Polyolefin–clay hybrids based on modified polyolefins and organoclay. Macromolecule Material Engineering, 280-281, 76–79.

He, J.D., Cheung, M.K., Yang, M.S. and Qi, Z. (2003) Thermal stability and crystallization kinetics of isotactic polypropylene/organomontmorillonite nanocomposites. Journal of Applied Polymer Science, 89, 3404–3415.

Hermosin, C., Pavlovic, J., Ulibarri, M.A. and Cornejo, J. (1996) Hydrotalcite as sorbent for trinitrophenol sorption capacity and mechanism. Water Research, 30, 171–177.

Hibino, T. and Tsunashima, A. (1998) Characterization of repeatedly reconstructed Mg-Al hydrotalcite-like compounds: gradual segregation of aluminium from the structure. Chemistry and Materials Science, 10, 4055–4061.

Ho, D.L. and Glinka, C.J. (2003) Effects of solvents solubility parameters on organoclay dispersions. Chemistry of Materials, 15, 1309–1312.

Hoffman, J.D., Williams, G. and Passaaglia, E. (1966) Analysis of the α, β and γ relaxations in polychlorotrifluoroethylene and polyethylene: Dielectric and mechanical properties. Journal of Polymer Science Part C, 14, 173–235.

Hoffman, U., Endell, K. and Wilm, D. (1933). Kristallstruktur and Quellung von Montmorillonit, Zeitschrift für Kristallographie, 86, 340–348.

Hotta, S. and Paul, D.R. (2004) Nanocomposites formed from linear low density polyethylene and organoclays. Polymer, 45, 7639–7654.

Hsueh, H.B. and C. Y. Chen, C.Y. (2003) Preparation and properties of LDHs/polyimide nanocomposites. Polymer, 44, 1151–1161.

Hsueh, H.B. and Chen, C.Y. (2003) Preparation and properties of LDHs/epoxy nanocomposites, Polymer, 44, 5275–5283.

Kaempfer, D., Thomann, R. and Mulhaupt, R. (2002) Melt compounding of syndiotactic polypropylene nanocomposites containing organophilic layered silicates and in situ formed core/shell nanoparticles. Polymer, 43, 2909–2916.

Kanezaki, E. (1998) Effect of atomic ratio Mg/Al in layers of Mg and Al layered double hydroxide on thermal stability of hydrotalcite-like layered structure by means of in situ high temperature powder X-ray diffraction. Materials Research Bulletin, 33, 773–778.

Karian, H.G. (1999) Handbook of Polypropylene and Polypropylene Composites. Marcel Dekker, New York.

Kashiwagi, T., Gilamn, J. W., Nyden, M. R., and Lomakin, S. M. (1998) Polymer Combustion and New Flame Retardants: Fire Retardancy of Polymers. Royal Society of Chemistry, 175–202.

Kato, M., Usuki, A. and Okada, A. (1997) Synthesis of Polypropylene Oligomer-Clay Intercalation Compounds. Journal of Applied Polymer Science, 66, 1781–1785.

Kawasumi M., Hasegawa N., Kato M., Usuki A., Okada A. (1997) Preparation and mechanical properties of polypropylene-clay hybrids. Macromolecules, 30, 6333–6338.

Khan, A.I. and O'Hare, D. (2002) Intercalation chemistry of layered double hydroxides: recent developments and applications, Journal of Materials and Chemistry, 12, 3191–3198.

Kim, C.M., Lee, D.H., Hoffmann, B., Kressler, J. and Stöppelmann, G. (2001) Influence of nanofillers on the deformation process in layered silicate/polyamide 12 nanocomposites. Polymer, 42, 1095–1100.

Kojima, Y., Usuki, A., Kawasumi, M., Okada, A., Fukushima, Y., Kurauchi, T. and Kamigaito, O. (1993) Mechanical properties of nylon 6-clay hybrid, Journal of Materials Research, 8, 1185–1189.

Kooli, F., Rives, V. and Ulibarri, M.A. (1994) Vanadate-pillared hydrotalcite containing transition metal cations. Materials Science Forum: Trans Tech Publications, 152–153, 375–378.

Kornmann, X. Lindberg, H. and Berglund, L.A. (2001) Synthesis of epoxy–claynanocomposites: influence of the nature of the clay on structure. Polymer, 42, 1303–1310.

Krishnamoorti, R. Vaia, R.A. and Giannelis, E.P. (1996) Structure and dynamics of polymer-layered silicate nanocomposites. Chemistry of Materials, 8, 1728–1734.

Krishnamoorti, R. and Giannelis, E.P. (1997) Rheology of end-tethered polymer layered-silicate nanocomposites, Macromolecules, 30, 4097–4102.

Krump, H., Luyt, A.S. and Hudec, I. (2006) Effect of different modified clays on the thermal and physical properties of polypropylene montmorillonite nanocomposites. Materials Letters, 60, 2877–2880.

Kuila, T., Srivastava, S.K. and Bhowmick, A.K. (2009) Ethylene vinyl acetate/ethylene propylene diene terpolymer-blend-layered double hydroxide nanocomposites. Polymer Engineering and Science, 49, 585–591.

Kuppinger, J., Göschel, U., B. Reeksting, B. and Vorster, O. (2007) Maleic anhydride grafted polypropylene- layered hydrotalcite master batch and resultand nanocomposites prepared by melt intercalation: structure characterization and mechanical properties. Journal of Polymer Engineering, 27, 339–355.

Kurokawa, Y., Yasuda, H., Kashiwagi, M. and Oya, A. (1997) Structure and properties of a montmorillonite/polypropylene nanocomposite. Journal of Materials Science Letters, 16, 1670–1672.

Lagaly, G. (1986) Interaction of alkylamines with different types of layered compounds, Solid State Ionics, 22, 43–51.

Lagaly, G. and Beneke, K. (1991) Intercalation and exchange reactions of clay minerals and non-clay layer compounds. Colloid & Polymer Science, 269, 1198–1211.

Lan, T., Kaviratna, P.D. and Pinnavaia, T.J. (1995) Mechanism of clay tactoid exfoliation in epoxy-clay nanocomposites, Chemistry of Materials, 7, 2144–2150.

Lan, T. and Pinnavaia, T.J. (1996) Nanolayer ordering in an epoxy-exfoliated clay hybrid composite. Materials Research Society Symposium Proceedings, 435, 79–84.

LeBaron, P.C., Wang, Z. and Pinnavaia, T.J. (1999) Polymer–layered silicate nanocomposites: an overview. Apply Clay Science, 15, 11–29.

Lee J.H., Jung, D., Hong, C.E., Rhee, K.Y. and Advani, S.G. (2005) Properties of Polyethylene-Layered Silicate Nanocomposites Prepared by Melt Intercalation with PP-g-MA Compatibilizer. Composites Science and Technology, 65, 1996–2002.

Lee, S.Y., and Kim, S. (2002) Expansion characteristics of organoclay as a precursor to nanocomposites. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 211, 19–26.

Lee, W.D., Im, S.S., Lim, H.M. and Kim. K.J. (2006) Preparation and properties of layered double hydroxide/poly(ethyleneterephthalate) nanocomposites by direct melt compounding. Polymer, 47, 1364–1371.

Lee, W.F. and Chen. Y.C. (2004) Superabsorbent polymeric materials, preparation and water absorbancy of nanocomposite superabsorbents containing intercalated hydrotalcite. Journal of Applied Polymer Science, 94, 2417-2424.

Lee, Y.J. and Lee, K.H. (2004) Characterization of organobentonite used for polymer nanocomposites. Materials Chemistry and Physics, 85, 410–415.

Leroux, F. and Basse, J.P. (2001) Polymer interleaved layered double hydroxide: a new emerging class of nanocomposites. Chemistry of Materails,13, 3507–3515.

Lertwimonnun, W. and Vergnes, B. (2005) Influence of Compatibiliser and Processing Conditions on the Dispersion of Nanoclay in a Polypropylene Matrix. Polymer. 46. 3462–3471.

Li, J., Zhou, C.X., Wang, G. and Zhao, D.L. (2003) Study on rheological behavior of polypropylene/clay nanocomposites. Journal of Applied Polymer Science. 89, 3609–3617.

Li, J., Zhou, C. and Gang, W. Study on nonisothermal crystallization of maleic anhydride grafted polypropylene/montmorillonite nanocomposite. Polymer Testing. 22, 217–223.

Li, S.C., Järvelä, P.K. and Järvelä, P.A. (1999) Melt Rheological Properties of Polypropylene-Maleated Polypropylene Blends: I. Steady Flow by Capillary Journal of Applied Polymer Science. 71, 1641–1648.

Li. Y., Zhao, B., Xie, S. and Zhang, S. (2003) Synthesis and properties of poly(methyl methacrylate)/montmorillonite (PMMA/MMT) nanocomposites. Polymer International. 52, 892–898.

Liang, J.Z. (2002) The elastic behaviour during capillary extrusion of LDPE/LLDPE blend melts. Polymer Testing. 21, 69–74.

Liang, J.Z. (2002) The melt elastic behavior of polypropylene/glass bead composites in capillary flow. Polymer Testing. 21, 927–931.

Liang, J.Z. (2004) A relationship between extrudate swell ratio and entry stored elastic strain energy during die flow of tyre compounds. Polymer Testing. 23, 441–446.

Liang, J.Z. (2002) Melt rheology of nanometre-calcium-carbonate-filled acrylonitrile-butadiene-styrene (ABS) copolymer composites during capillary extrusion Polymer International. 51, 1473–1478.

Liang, J.Z. and Ness, J.N. (1998) The melt die-swell behaviour during capillary extrusion of LDPE/PP blends. Polymer Testing. 17, 179–189.

Lim, Y.T. and Park, O. (2001) Phase morphology and rheological behavior of polymer/layered silicate nanocomposites. Rheological Acta. 40, 220–229.

Lincoln. D.M., Vaia, R.A., Wang, Z.G. and Hsiao. B.S. Secondary structure and elevated temperature crystallite morphology of nylon-6/layered silicate nanocomposites. Polymer. 42, 1621–1631.

Liu, X. and Wu, Q. (2001) PP/clay nanocomposites prepared by grafting melt intercalation. Polymer, 42, 10013–10019.

Machado, G., Denardin, E.L.G., Kinast, E.J., Goncalves, M.C., de Luca, M.A., Teixeira, S.R. and Samios, D. (2005) Crystalline properties and morphological change in plastically deformed isotactic polypropylene evaluated by X-ray diffraction and transmission electron microscopy. European Polymer Journal. 41, 129–138.

Maiti, P., Na, P.H., Okamoto, M., Hasegawa, N. and Usuki, A. (20020 Influence of crystallization on intercalation, morphologi, and mechanical properties of polypropylene/clay nanocomposites, Macromolecules, 35, 2042–2049

Manias, E., Chen, H., Krishnamoorti, R.K., Genzer, J., Kramer, E.J. and Giannelis, E.P. (2000) Macromolecules, 33:7955–7966.

Manias, E., Touny, A., Wu, L., Lu, B., Strawhecker, K. and Chung, T.C. (2000) Polypropylene/silicate nanocomposites, synthetic routes and materials properties. Polymeric Materials Science and Engineering, 82, 282–283.

Manias, E., Touny, A., Wu, L., Strawhecker, K., Lu, B. and Chung, T.C. (2001) Polypropylene/Montmorillonite Nanocomposite Materials. Review of Synthetic Routes and Materials Properties. Chemistry of Materials, 13, 3516–3523.

Marchant, D. and Jayaraman, K. (2002) Strategies for Optimizing Polypropylene-Clay Nanocomposite Structure. Industrial & Engineering Chemistry Research, 41, 6402–6408.

Mascolo, G. (1995) synthesis of anionic clays by hydrothermal crystallization of amorphous precursors. Applied Clay Science, 10, 21–30.

McCrum, N.G., Read, B.E., Williams G. (1967) An elastic and dielectric effects in polymeric solids. Wiley, London.

Meille, S.V., Bruckner, S. and Porzio, W. (1990) gramma-Isotactic polypropylene. A structure with nonpararell chain axes. Macromolecules, 23, 4114–4121.

Mering, J. (1946) On the hydration of montmorillonite, Transactions of the Faraday Society, 42B, 205–219.

Messersmith, P.B. and Stupp, S.I. (1995) High-temperature chemical and microstructural transformations of a nanocomposite organoceramic. Chemisty of Materials, 7, 454–560.

Messersmith, P.B. and Giannelis, E.P. (1995) Synthesis and barrier properties of poly(ε-caprolactone)-layered silicate nanocomposites. Journal of Polymer Science, Part A: Polymer Chemistry, 33, 1047–1057.

Meyn, M., Beneke, K. and Lagaly, G. (1990) Anion-exchange reactions of layered double hydroxides. Inorganic Chemistry, 29, 5201–5207.

Meyn, M., Beneke, K. and Legaly, G (1993) Anionic-exchange reactions of hydroxy double salts. Inorganic chemistry, 32, 1209–1215.

Miyata. S. (1980) Physico-chemical properties of synthetic hydrotalcites in relation to composition. Clays and Clay Minerals, 28, 50–56.

Miyata, S. (1983) Anion-exchange properties of hydrotalcite-like compounds. Clays and Clay Minerals, 31, 305–311.

Miyata, S. and Kumara, T. (1973) Synthesis of new Hydrotalcite-like compounds and their physico-chemical properties. Chemistry Letters, 2, 843–848.

Modesti, M. Lorenzetti, A., Bon, D. and Besco, S. (2006) Thermal behaviour of compatibilised polypropylene nanocomposite: Effect of processing conditions. Polymer, 46, 10237–45.

Muksing, N., Nithitanakul, M., Grady, B.P. and Magaraphan, R. (2008) Melt rheology and extrudate swell of organobentonite-filled polypropylene nanocomposites. Polymer Testing, 27, 470–479.

Munzy, C.D., Butler, B.D., Hanley, H.J.M., Tsvetkov, F. and Pfeiffer, D.G. (1996) Clay platelet dispersion in a polymer matrix. Materials Letters, 28, 379–384.

Natta, G. and Corradini, P., (1960) Crystal structure of isotactic poly(1-butene). Nuovo Cimento, 15, 40.

Newman, S.P. and Jones, W. (1998) Synthesis, characterization and applications of layered double hydroxides containing organic guests. New Journal of Chemistry, 22, 105–115.

Okada, A., Kawasumi, M., Usuki, A., Kojima, Y., Kurauchi, T. and Kamigaito, O. (1990) Nylon 6-clay hybrid, Materials Research Society Symposium Proceedings, 171, 45–50.

Okamoto, M., Nam, P.H., Maiti, P., Kotaka, T. and Hasegawa, N. (2001) A hierarchical structure and properties of intercalated polopropylene/clay nanocomposites. Polymer, 42, 9633–9640.

O'Leary, S., O'Hare, D., and Seely, G. (2002) Delamination of layered double hydroxides in polarmonomers: new ldh-acrylate nanocomposites. Chemical Communication, 14, 1506–1507.

Ogawa, M. and Kuroda, K. (1997) Preparation of Inorganic–Organic Nanocomposites through Intercalation of Organoammonium Ions into Layered Silicates. Bulletin of the Chemical Society of Japan, 70, 2593–2518.

Oya, A., Kurokawa, Y. and Yasuda, H. (2000) Factors Controlling Mechanical Properties of Clay Mineral/Polypropylene Nanocomposites. Journal of Materials Science Letters, 35, 1045–1050.

Padden, F. J. and Keith, H. D. (1959) Spherulific crystallization in polypropylene. Journal of Applied Physics, 30, 1479–1484.

Passaglia, E., Bertoldo, M., Ceriegi, S., Sulcis, R., Narducci, P. and Conzatti, L. (2008) Oxygen and water vapor barrier properties of MMT nanocomposites from low density polyethylene or EPM with grafted succinic groups. Journal of Nanoscience and Nanotechnology, 8, 1690–1699.

Passaglia, E., Bertuccelli, W. and Ciardelli, F. Composites from functionalized polyolefins and silica. Macromolecular Symposia, 176, 299–315.

Passaglia, E., Bertoldo, M., Ciardelli, F., Prevosto, D. and Lucchesi, M. (2008) Evidences of macromolecular chains confinement of ethylene-propylene copolymer in organophilic montmorillonite nanocomposites. European Polymer Journal, 44, 1296–1308.

Passaglia, E., Sulcis, R., Ciardelli, F., Malvaldi M. and Narducci, P. (2005) Effect of functional groups of modified polyolefins on the structure and properties of their composites with lamellar silicates. Polymer International, 54, 1549–1556.

Paul, D.R, Zeng, Q.H., Yu, A.B. and Lu, G.Q. (2005) The swelling and molecular packing in organoclays. Journal of Colloid and Interface Science, 292, 462–468.

Pavan, P.C., Crepaldi, E.L., Gomes, G.D. and Valim, J.B. (1999) Adsorption of sodium dodecylsulfate on a hydrotalcite-like compound: Effect of temperature, pH and ionic strength. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 154, 399–410.

Peltola, P., Valipakka, E., Vuorinen, J., Syrjala, S. and Hanhi, K. (2006) Effect of rotational speed of twin screw extruder on the microstructure and rheological and mechanical properties of nanoclay-reinforced polypropylene nanocomposites. Polymer Engineering and Science, 46, 995–1000.

Perrin-Sarazin, F., Ton-That, M.T., Bureau, M.N. and Denault, J. (2005) Micro-and nano-structure in polypropylene/clay nanocomposites. Polymer, 46, 11624–11634.

Picard, E., Gauthier, H., G`erard, J.F. and Espuche, E. (2007) Influence of the intercalated cations on the surface energy of montmorillonites: Consequences for the morphology and gas barrier properties of polyethylene/montmorillonites nanocomposites. Journal of Colloid and Interface Science, 307, 364–376.

Preschilla, N., Sivalingam, G., Rasheed, A.S.A., Tyagi, S., Biswas, A. and Bellare, J.R. (2008) Quantification of organoclay dispersion and lamellar morphology in poly(propylene)-clay nanocomposites with small angle X-ray scattering. Polymer, 49, 4285–4297.

Prevot, V., Forano, C. and Besse, J.P. (2001) Hybrid derivatives of layered double hydroxides. Applied Clay Science, 18, 3–15.

Qian, M. and Zeng, H.C. (1997) Synthesis and characterization of Mg–Co catalytic oxide materials forlow-temperature N_2O decomposition. Journal of Materials Chemistry, 7, 493–499.

Qiu, L., Chen, W. and Qu, B. (2005) Structural characterization and thermal properties of exfoliated polystyrene/ZnAl layered double hydroxide nanocomposites prepared via solution intercalation. Polymer Degradation and Stability, 87, 433–440.

Qiu, L., Chen, W. and Qu, B. (2006) Morphology and thermal stabilization mechanism of LLDPE/MMT and LLDPE/LDH nanocomposites, Polymer, 47, 922–930.

Ramos Filho, F.G., Mélo, T.J.A., Rabello, M.S. and Silva, S.M.L. (2005) Thermal stability of nanocomposites based on polypropylene and bentonite. Polymer Degradation and Stability, 89, 383–92.

Ray, S.S. and Okamoto, M. (2003) Polymer–layered silicate nanocomposite: a review from preparation to processing. Progress in Polymer Science, 28, 1539-641.

Reichert, P., Nitz, H., Klinke, S., Brandsch, R., Thomann, R. and Mulhaupt, R. (2000) Poly(propylene)/ organoclay nanocomposite formation: Influence of compatibilizer functionality and organoclay modification. Macromolecular Materials and Engineering, 275, 8–17.

Reichle. W.T. (1986) Synthesis of anionic clay minerals (mixed metal hydroxides, hydrotalcite). Solid state Ionics, 22, 135–41.

Ren, J. and Krishnamoorti, R. (2003) Nonlinear Viscoelastic Properties of Layered-Silicate-Based Intercalated Nanocomposites. Macromolecules, 36, 4443–4451.

Ren, J., Silva, A.S. and Krishnamoorti, R. (2000) Linear Viscoelasticity of Disordered Polystyrene-Polyisoprene Block Copolymer Based Layered-Silicate Nanocomposites. Macromolecules, 33, 3739–3746.

Rytwo, G., Serban, C., Nir, S. and Margulies, L. (1991). Use of methylene blue and crystal violet for determination of exchangeable cations in montmorillonite. Clays and Clay Minerals, 39, 551–555.

Sadhu, S. and Bhowmick, A.K. (2005) Unique rheological behavior of rubber based nanocomposite. Journal of Polymer Science Part B: Polymer Physics, 43, 1854–1864.

Saini, D.R., Shenoy, A.V. and Nadkarni, V.M. (1986) Melt rheology of highly loaded ferrite-filled polymer composites. Polymer Composites, 7, 193–200.

Samsudin, M.S.F., Mohd Ishak, Z.A., Jikan, S.S., Ariff, Z.M. and Ariffin, A. (2006) Effect of filler treatments on rheological behavior of calcium carbonate and talc-filled polypropylene hybrid composites. Journal of Applied Polymer Science, 102, 5421–5426.

Sato, T., Fujita, H., Endo, T., Shimada, M. and Tsunashima, A. (1988) Synthesis of hydrotalcite-like compounds and their physico-chemical properties. Reactivity of Solids, 5, 219–228.

Seo, Y., Kim, J., Kim, K.U. and Kim, Y.C. (2000) Study of the crystallization behaviors of polypropylene and maleic anhydride grafted polypropylene. Polymer, 41, 2639–2646.

Sinha Ray, S., Yamada, K., Okamoto, M. and Ueda, K. (2002) Polylactide-layered silicate nanocomposite: A novel biodegradable material. Nano Letters, 2, 1093–1096.

Solomon, J.M., Almusallam, S.A., Seefeld, F.K., Somwangthanaroj, A. and Varadan, P. (2000) Rheology of polypropylene/clay hybrid materials. Macromolecules, 34, 1864–1872.

Sun, T. and Garces, J.M., (2002) High-performance polypropylene–clay nanocomposites by in-situ polymerization with metallocene/ clay catalysts. Advance Material, 14, 128–130.

Svoboda, P., Zeng C., Wang H., JamesLee L. and Tomasko D.L. (2002) Morphology and mechanical properties of polypropylene/organoclay nanocomposites, Journal of Applied Polymer Science, 85, 1562–1570.

Tammaro, L., Tortora, M., Vittoria, V., Costatino, U. and Marmottini, F. (2005) Methods of preparation of novel composites of poly(ε-caprolactone) and a modified Mg/Al hydrotalcite. Journal of Polymer Science, Part A: Polymer Chemistry, 43, 2281–2290.

Tang, Y., Hu, Y., Song, Lei., Zong, R., Gui, Z., Chen, Z. and Fan, W. (2003) Preparation and thermal stability of polypropylene/montmorillonite nanocomposites. Polymer Degradation and Stability, 82, 127–131.

Treece, M.A. and Oberhauser, J.P. (2007) Soft Glassy Dynamics in Polypropylene–Clay Nanocomposites. Macromolecules, 40, 571–582.

Tudor, J., Willington, L., O'Hare, D., Royan, B. (1996) Intercalation of catalytically active metal complexes in phyllosilicates and their application as propene polymerization catalyst. Chemical Community, 2031–2032.

Turner-Jones, A., Aizlewood, J. M. and Beckett, D. R. (1964) Crystalline forms of isotactic polypropylene. Makromolekulare Chemie, 75, 134–158.

Usuki, A., Kato, M., Okada, A. And Kurauchi, T. (1997) Synthesis of polypropylene–clay hybrid. Journal of Applied Polymer Science, 63, 137–138.

Usuki, A., Kawasumi, T., Kojima, M., Fukushima, Y., Okada, A., Kurauchi, T. and Kamigaito, O. (1993) Synthesis of nylon 6-clay hybrid. Journal of Materials Research, 8, 1179–1184.

Vaia, R.A. and Giannelis, E.P (1997) Lattice model of polymer melt intercalation in organically-modified layered silicates. Macromolecules, 30, 7990–7999.

Vaia, R.A. and Giannelis, E.P (1997) Polymer melt intercalation in organically-modified layered silicates: Model predictions and experiment. Macromolecules, 30, 8000–8009.

Vaia, R.A. and Giannelis, E.P. (2001) Polymer nanocomposites: status and opportunities. MRS Bulletin, 26, 394–401.

Vaia, R.A., Ishii H. and Giannelis, E.P. (1993) Synthesis and properties of two-dimensional nanostructures by direct intercalation of polymer melts in layered silicates. Chemical Material, 5, 1694–1696.

Vaia, R.A., Jandt, K.D., Kramer, E.J. and Giannelis, E.P. (1995) Kinetics of polymer melts intercalation. Macromolecules, 28, 8080–8085.

Vaia, R.A. and Liu, W. (2002) X-ray powder diffraction of polymer/layered silicate nanocomposites: Model and practice. Journal of Polymer Science, Part B: Polymer Physics, 40, 1590–1600.

Vaia, R.A., Sauer, B.B., Tse, O.K. and Giannelis, E.P. (1997) Relaxations of confined chains in polymer nanocomposites: Glass transition properties of poly(ethylene oxide) intercalated in montmorillonite. Journal of Polymer Science, Part B: Polymer Physics, 35, 59–67.

Velu, S., Amkumar, V., Narayanan, V. and Swamy, C.S. (1997) Effect of interlayer anions on the physicochemical properties of zinc–aluminium hydrotalcite-like compounds. Journal of Metrial Science, 32, 957–964.

Wang, D., Xu, D., Zhang, X., Yang, M. and Dong, X. (2004) Polypropylene/montmorillonite composites and their application in hybrid fiber preparation by melt-spinning. Journal of Applied Polymer Science, 92, 552–558.

Wang, K., Liang, S., Deng, J., Yang, H., Zhang, Q., Fu, Q., Dong, X., Wang, D., Han, C.C. (2006) The role of clay network on macromolecular chain mobility and relaxation in isotactic polypropylene/organoclay nanocomposites. Polymer, 47, 7131–7144.

Wang, K., Liang, Si., Rongni, D., Zhang, Q. and Fu, Q. (2004) The interplay of thermodynamics and shear on the dispersion of polymer nanocomposite. Polymer, 45, 7953–7960.

Wang, K., Liang, S., Zhang, Q., Du, R. and Fu, Q. (2005) An observation of accelerated exfoliation in iPP/organoclay nanocomposite as induced by repeated shear during melt solidification. Journal of Polymer Science Part B: Polymer Physics, 43, 2005–2012.

Wang, K.H., Choi, M.H., Koo, C.M., Choi, Y.S. and Chung, I.J. (2001) Synthesis and characterization of maleated polyethylene/clay nanocomposites. Polymer, 42, 9819–9826.

Wang, Y., Che, F.B., Li, Y.C. and Wu, K.C. (2004) Melt processing of polypropylene/clay nanocomposites modified with maleated polypropylene compatibilizers. Composites: Part B, Engineering, 35, 111–124.

Wang, Z. and Pinnavaia, T.J. (1998) Hybrid organic-inorganic nanocomposites: exfoliation of magadiite nanolayers in an elastomeric epoxy polymer, Chemistry Materials, 10, 1820–1826.

Wang, Z. and Piannavaia, T.J. (1998) Nanolayer reinforcement of elastomeric polyurethane. Chemistry Materials, 10, 3769–3771.

Wolf, D., Fuchs, A., Wagenknecht, U., Kretzschmar, B. and Jehnichen, D. (1999) In: Proceedings of the Eurofiller'99, Lyon-Villeurbanne, 6–9 September.

Wu, J. and Lerner, M. (1993) Structural, thermal, and electrical characterization of layered nanocomposites derived from sodium-montmorillonite and polyethers. Chemistry of Materials, 7, 835–838.

Xi, Y., Ding, Z., He, H. and Frost, R.L. (2004) Structure of organoclays - an X-ray diffraction and thermogravimetric analysis study. Journal of Colloid and Interface Science, 277, 116–120.

Xie, Y., Yu, D., Kong, J., Fan, X. and Qiao, W. (2006) Study on morphology, crystallization behaviors of highly filled maleated polyethylene-layered silicate nanocomposites. Journal of Applied Polymer Science, 100, 4004–4011.

Xu, W., Liang, G.D., Zhai, H., Tang, S., Hang, G. and Pan, W. (2003) Preparation and crystallization behaviour of PP/PP-g-MAH/Org-MMT nanocomposite. European Polymer Journal, 39, 1467–1474.

Xu, Z.P. and Zeng H.C. (1998) Thermal evolution of cobalt hydroxides: a comparative study of their various structural phases. Journal of Materials Chemistry, 8, 2499–2506.

Yang, Y., Zhu, Z.K., Yin, J., Wang, X.Y. and Qi, Z.E. (1999) Preparation and properties of hybrids of organo-soluble polyimide and montmorillonite with various chemical surface modification methods Polymer, 40, 4407–4414.

Yano, K., Usuki, A., Okada, A., Kurauchi, T. and Kamigaito, O. (1993) Synthesis and properties of polyimide-clay hybrid. Journal of Polymer Science Part A: Polymer Chemistry, 31, 2493–2498.

Yao, K., Taniguchi, M., Nakata, M., Takahashi, M. and Yamagishi, A. (1998) Nanoscale Imaging of Molecular Adsorption of Metal Complexes on the Surface of a Hydrotalcite Crystal. Langmuir, 14, 2410–2414.

Yoon, P.J., Hunter, D.L. and Paul, D.R. (2003) Polycarbonate nanocomposites. Part 1. Effect of organoclay structure on morphology and properties. Polymer, 44, 5323–5339.

You, Y., Zhao, H. and Vance, G.F. (2002) Hybrid organic-inorganic derivatives of layered double hydroxides and dodecylbenzenesulfonate: Preparation and adsorption characteristics. Journal of Materials Chemistry, 12, 907–912.

Yu, C., Zhu, M., Shong, X. and Chen, Y. (2001) Study on Dyable Polypropylene fiber and Its Properties. Journal of Applied Polymer Science, 82, 3172–3176.

Yu, Y.H., Yeh, J.M., Liou, S.J. and Chang, Y.P. (2004) Organo-Soluble Polyimide (TBAPP-OPDA)/Clay Nanocomposite Materials with Advanced Anticorrosive Properties Prepared from Solution Dispersion Technique. Acta Materialia, 52, 475–486.

Yuan, Q., Awate, S. and Misra, R.D.K. (2006) Nonisothermal crystallization behavior of melt-intercalated polyethylene-clay nanocomposites. Journal of Applied Polymer Science, 102, 3809–3818.

Zammarano, M., Bellayer, S., Gilman, J.W., Franceschi, M., Beyer, F.L., Harrisa, R.H. and Meriani, S. (2006) Delamination of organo-modified layered double hydroxides in polyamide 6 by melt processing. Polymer, 47, 652–662.

Zanetti, M., Kashivagi, T., Falqui, L. and Camino, U. (2002) Cone Calorimeter Combustion and Gasification Studies of Polymer Layered Silicate Nanocomposites. Chemistry of Materials, 14, 881–887.

Zhong, Y., Zhu, Z. and Wang, S.Q. (2005) Synthesis and rheological properties of polystyrene/layered silicate nanocomposite. Polymer, 46, 3006–3013.

Zhu, J., Uhl, F.M., Morgan, A.B. and Wilkie, C.A. (2001) Studies on the mechanism by which the formation of nanocomposites enhances thermal stability. Chemistry of Materials, 13, 4649–4654.

Zhu, L. and Xanthos, M. (2004) Effect of Process Conditions and Mixing Protocols on Structure of Extruded Polypropylene Nanocomposites. Journal of Applied Polymer Science, 93, 1891–1899.

APPENDICES

Appendix A Some Calculations for Layered Clays

Cation Exchange Capacity (CEC)

2.0 grams of purified clay were dispersed in 300 mL. The dispersion was stirred until a uniform dispersion is obtained. The pH value was adjusted to 2.5 to 3.8 by sulfuric acid. The suspension was continued stirring for 15 min. Methylene blue solution (0.01 N) was added slowly by buret into the clay slurry while maintains a constants stirring. A drop of the suspended solution was place on a filter paper for end point detection. The end point was indicated by a formation of light blue halo around the drop. The methylene was continued to add at 1.0 mL increasing until the end point was reached. After the end point was reached, the solution was stirred of 2 min and retest for the end point.

The calculation the methylene blue index can calculated from below equation:

$$MBI = \frac{E * V * 100}{W}$$

where:

MBI = methylene blue index for the clay in meq/100 g clay

E = concentration of the methylene blue (in milliequivalents of methylene blue per milliter)

V = amount of methylene blue (in milliliter) required for the titration

W = weight of dry clay in gram

Swelling Index of layered silicate

The swelling index of layered silicate clays was measured by the following method (D 5890-02): 2 g of the clay was poured into 100 ml of distilled water (or *n*-dodecane) in a mass cylinder. After 24 h, the apparent volumes of the swelling clays were measured.

Chemical formula of Organomodified LDHs

LDH-NO_3

Formula = $Mg_{0.66}Al_{0.34}(OH)_2(NO_3)_{0.34} \cdot xH_2O$, calculation x value

Amount of water = 9.3% (from TGA analysis)

x (mol of water) = ((9.3/18)/100)/(80.298+18x)

100x = 41.49 + 9.3x

x = 0.46

So molecular of LDH-NO_3 = $Mg_{0.66}Al_{0.34}(OH)_2(NO_3)_{0.34} \cdot 0.46H_2O$

LDH -C8:

Sodium 2-ethylhexyl sul fate (C6, branch C2)

MW = 232 g/mol , but real MW inside LDH = 232-23 = 209 g/mol

Formula = $Mg_{0.66}Al_{0.34}(OH)_2(CO_3^{2-})_z(\text{LDH-C8})_y \cdot xH_2O$, calculation x, y, and z

Amount of water = 8.1%

Residue = 40.8%

Note: from TGA analysis the residue is = $Mg_{0.66}Al_{0.34}O_{1.17}$, MW = 43.34 g/mol

MW_{tot} : 100 = 43.34: 40.8

MW_{tot} = 106.22 g/mol → LDH-C8

Calculate x:

x = ((8.1/18)/100)/106.22

= 0.48

Calculate y:

106.22 = 59.22+(60(0.34-y)/2)+209y+(0.48)18

y = 0.157

Calculate z:

2z +y = 0.34

z = 0.092

***LDH-C8 formula = $Mg_{0.66}Al_{0.34}(OH)_2(CO_3^{2-})_{0.092}(\text{LDH-C8})_{0.157} \cdot 0.48H_2O$

Real MW of LDH-C8 = 106.19 g/mol

LDH-C12

Sodium dodecyl sulfate (C12) -SDS

MW = 288 g/mol , but real MW inside LDH = 288-23 = 265 g/mol

Formula = $Mg_{0.66}Al_{0.34}(OH)_2(CO_3^{2-})_z(LDH\text{-}DS)_y{\bullet}xH_2O$,

calculation x, y, and z

Amount of water = 8.8%

Residue = 38.8%

Note: from TGA analysis the residue is = $Mg_{0.66}Al_{0.34}O_{1.17}$, MW = 43.34 g/mol

MW_{tot} : 100 = 43.34: 38.8

MW_{tot} = 111.41 g/mol → LDH-DS

Calculate x:

x = ((8.8/18)/100)/111.41

= 0.54

Calculate y:

111.41 = 59.22+(60(0.34-y)/2)+265y+(0.54)18

y = 0.137

Calculate z:

from 2z +y = 0.34

z = 0.10

***LDH-C12 formula = $Mg_{0.66}Al_{0.34}(OH)_2(CO_3^{2-})_{0.1}(LDH\text{-}C8)_{0.137}{\bullet}0.54H_2O$

Real MW of LDH-DS = 111.25 g/mol

LDH –C20

Sodium eicosyl sul fate (C20)

MW = 379 g/mol, but real MW inside LDH = 379-23 = 356 g/mol

Formula = $Mg_{0.66}Al_{0.34}(OH)_2(CO_3^{2-})_z(LDH\text{-}C20)_y{\bullet}xH_2O$,

calculation x, y, and z

Amount of water = 7.6%

Residue = 28.6%

Note: from TGA analysis the residue is = $Mg_{0.66}Al_{0.34}O_{1.17}$, MW = 43.34 g/mol

$MW_{tot} : 100 = 43.34 : 28.6$

$MW_{tot} = 151.54$ g/mol → LDH-C20

Calculate x:

$x = ((7.6/18)/100)/151.54$

$= 0.64$

Calculate y:

$151.54 = 59.22+(60(0.34-y)/2)+356y+(0.64)18$

$y = 0.216$

Calculate z:

from $2z + y = 0.34$

$z = 0.062$

***Real formula = $Mg_{0.66}Al_{0.34}(OH)_2(CO_3^{2-})_{0.062}(LDH\text{-}C8)_{0.216}\cdot 0.64H_2O$

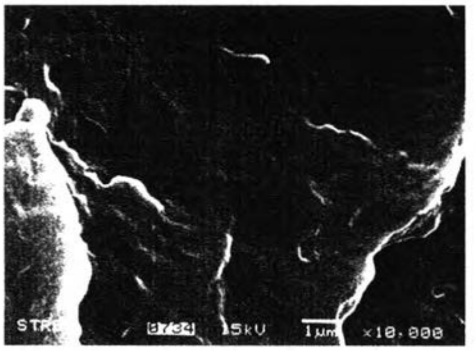
Real MW of LDH-DS = 151.36 g/mol

Appendix B Supplementary Results of Chapter IV

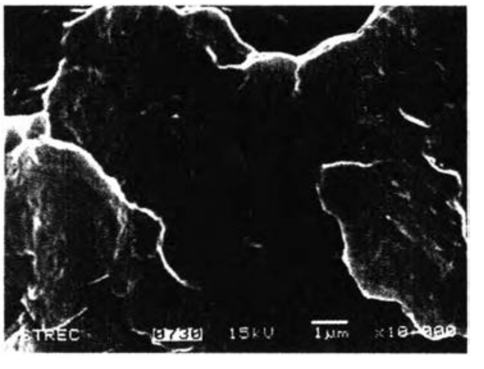
SEM image of PP/OBTN nanocomposites

The dispersion of clay particles and the extent of intercalated/exfoliated structure of PP/clay nanocomposites were characterized by electron microscopy (SEM) at 10,000 magnifications, shown in Figure B1.

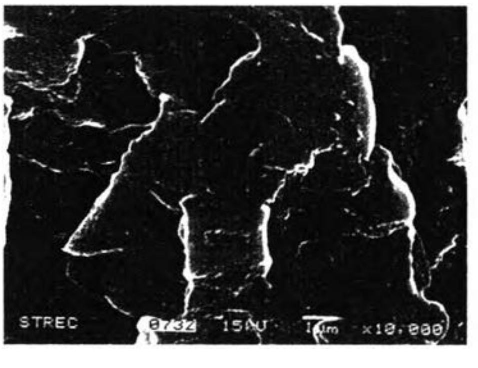
PP



1wt% CTAB-clay



3wt% CTAB-clay



5wt% CTAB-clay

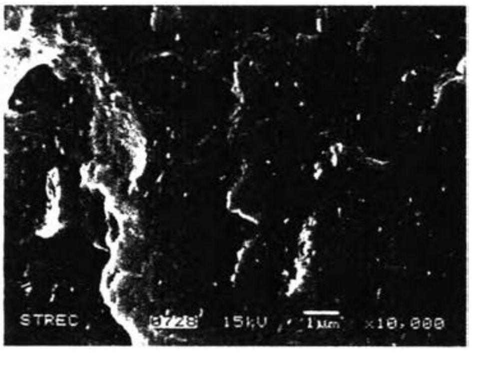


Figure B1 SEM images of PP/CTAB-clay nanocomposites at magnifications of X10000.

Appendix C Supplementary Results of Chapter VII

Table C1 Assignment of various XRD reflections for LDH-NO_3 and Organo-LDHs

Materials	reflections in <*00l*> series					
	<003>		<006>		<009>	
	2θ (deg)	*d* (nm)	2θ (deg)	*d* (nm)	2θ (deg)	*d* (nm)
LDH-CO_3	11.69	0.76	23.40	0.38	34.62	0.26
LDH-NO_3	9.91	0.89	19.88	0.45	34.62	0.26
LDH-NO_3_C8	4.16	2.12	8.46	1.04	12.55	0.74
LDH-NO_3_C12	3.65	2.42	7.25	1.22	10.85	0.81
LDH-NO_3_C20	2.72	3.25	5.49	1.61	8.27	1.07

Table C2 Assignment of various XRD reflections obtained for LDPE/modified LDHs composites

Sample	reflections in <*00l*> series					
	<003>		<006>		<009>	
	2θ (deg)	*d* (nm)	2θ (deg)	*d* (nm)	2θ (deg)	*d* (nm)
LDH-NO_3	9.91	0.89	19.88	0.45	34.62	0.26
LDPE-C8	3.89	2.27	8.10	1.09	ND	ND
LDPE_DS	3.24	2.72	6.70	1.32	9.39	0.94
LDPE_C20	2.32	3.80	4.82	1.83	7.39	1.20

Table C3 Assignment of FTIR bands in LDH-NO_3 and Organomodified LDHs

Materials	Band position (cm^{-1})	Types of Vibration
LDH-NO_3	3468	ν_{-OH} (OH of LDH or co-intercalated
	1384	ν_{-NO3} (asymmetric)
	680	Al-OH (translation mode)
	550	Mg-OH (translation mode)
LDH-NO_3_C8	3479	ν_{-OH} (OH of LDH or co-intercalated
	2919, 2852	ν_{-CH2}
	1219	$\nu_{S=O}$ (symmetric)
	1065	$\nu_{S=O}$ (asymmetric)
	630	ν_{C-S}
	671, 818, 1371 and 1468	Different vibration modes of CO_3^{2-}
LDH-NO_3_DS	3479	ν_{-OH} (OH of LDH or co-intercalated
	2919, 2852	ν_{-CH2}
	1217	$\nu_{S=O}$ (symmetric)
	1066	$\nu_{S=O}$ (asymmetric)
	630	ν_{C-S}
	678, 816, 1370 and 1470	Different vibration modes of CO_3^{2-}
LDH-NO_3_C20	3479	ν_{-OH} (cointercalated water molecules)
	2919, 2851	ν_{-CH2}
	1219	$\nu_{S=O}$ (symmetric)
	1064	$\nu_{S=O}$ (asymmetric)
	630	ν_{C-S}
	680, 820, 1371 and 1470	Different vibration modes of CO_3^{2-}

Table C4 Designing formula for preparing LDPE/LDHs-nanocomposites

Sample	LDPE (g)	PE-g-MA (g)	LDH (g)
LDPE/LDPE-g-MA	19.5	0.5	-
LDH-C8 composite	19.5	0.5	0.5
LDH-DS composite	19.5	0.5	0.5
LDH-C20 composite	19.7	0.3	0.3

Processing conditions in Babender:

Temperature = 170 °C

Speed = 80 rpm

Residence time = 20 min.

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Publications:

1. Muksing, N., Nithitanakul, M., Grady, BP., and Magaraphan, Rathanawan., (2008) Melt rheology and extrudate swell of organobentonite-filled polypropylene nanocomposites. Polymer Testing, 27, 470-479.
2. Muksing, N., Coiai, S., Conzatti, L., Passaglia, E., Magaraphan, R., and Ciardelli., F. (2009). Morphology development and stability of polypropylene/organoclay nanocomposites. Journal of Nanoscience and Nanotechnology, 10, 1-12.
3. Muksing, N., Coiai, S., Passaglia, E. and Magaraphan, R. (2010). Effect of surfactant alkyl chain length on the dispersion, and thermal and dynamic mechanical properties of LDPE/organo-LDH composites.eXPRESS Polymer Letters, 15, 428–448.

Proceedings:

1. Muksing, N., Coiai, S., Conzatti, L., Passaglia, E., Magaraphan, R., and Ciardelli, F. (2010, April 7-10). Evidence of anionic guests intercalated layered double hydroxide host on morphology and thermal properties of LDPE based nanocomposites. Paper present at The POLYCHAR18–World Forum on Advanced Materials, Siegen, Germany (Poster prize).
2. Muksing, N., Nithitanakul, M., Grady, BP., and Magaraphan, R. (2008, June 15-19) Melt rheology and extrudate swell of organobentonite-filled polypropylene nanocomposites. Proceedings of the 24th Polymer Processing Society Annual Meeting (PPS-24), Salerno, Italy.
3. Muksing, N., Nithitanakul, M., and Magaraphan, R. (2006, October 10-13) Effect of clay contents on morphology, thermal and mechanical properties of polypropylene nanocomposites. Proceedings of the IUPAC International Symposium on Advanced Polymers for Emerging Technologies (The 30th PSK), Busan, Korea.
4. Muksing, N., Jirakittidul, K., Phandee, A., Leungsuklerk, S., Nithitanakul, M., Manuspiya, M., and Magaraphan, M., (2005, December 6-7) Modification of the local clay used for polymer nanocomposites. Proceedings of the First Mathematics and Physical Science Graduate Congress, Bangkok, Thailand.
5. Sinthavathavorn, W., Aimampaiwong, A., Muksing, N., Manit Nithitanakul, M., Hathaikarn Manuspiya, H., and Magaraphan, R. (2008, January 30 - Febuary 1) Effect of draw ratio on mechanical and dye ability of polypropylene-organoclay nanocomposite fiber. Proceedings of the Pure and Applied Chemistry Conference 2008 (PACCON), Bangkok, Thailand.
6. Coiai, S., Passaglia, E., Muksing, M., Conzatti, L., Sisani, M., and Costantino, U. (2009, September 13-17). Effects of organo-layered double hydroxide structure on morphology and thermal properties of LDPE based nanocomposites. Proceedings of the Associazione Italiana di Scienza e Tecnologia delle Macromolecole (AIM), XIX Convegno, Milan, Italy.

7. Passaglia, E., Taburoni, E., Bertoldo, M., Conzatti, L., Coiai, S., Muksing, M., and Ciardelli, F. (2009, September 13-17). Evidence of polyolefins/clay molecular interaction at the interface of nanocomposites. Proceedings of the Associazione Italiana di Scienza e Tecnologia delle Macromolecole (AIM), XIX Convegno, Milan, Italy.

Presentations:

1. Muksing, N., Coiai, S., Conzatti, L., Passaglia, E., Magaraphan, R., and Ciardelli, F. (2010, April 7-10). Evidence of anionic guests intercalated layered double hydroxide host on morphology and thermal properties of LDPE based nanocomposites. Paper present at The POLYCHAR18–World Forum on Advanced Materials, Siegen, Germany (Poster prize).
2. Muksing, N., Nithitanakul, M., Grady, BP., and Magaraphan, R. (2008, June 15-19) Melt rheology and extrudate swell of organobentonite-filled polypropylene nanocomposites. Paper present at The 24th Polymer Processing Society Annual Meeting (PPS-24), Salerno, Italy.
3. Muksing, N., Aimampaiwong, A., Sinthavathavorn, W., Nithitanakul, M., Manuspiya, H., and Magaraphan, R. (2008, January 30-Febuary 1) Effect of Compatibilizers on Mechanical and Dyeability of PP/Organoclay Nanocomposite Fibers. Paper present at The Pure and Applied Chemistry Conference 2008 (PACCON), Bangkok, Thailand.
4. Muksing, N., Nithitanakul, M., and Magaraphan, R. (2006, October 10-13) Effect of clay contents on morphology, thermal and mechanical properties of polypropylene nanocomposites. Paper present at The IUPAC International Symposium on Advanced Polymers for Emerging Technologies (The 30th PSK), Busan, Korea.
5. Muksing, N., Jirakittidul, K., Phandee, A., Leungsuklerk, S., Nithitanakul, M., Manuspiya, M., and Magaraphan, R. (2005, December 6-7) Modification of the local clay used for polymer nanocomposites. Proceedings of the First Mathematics and Physical Science Graduate Congress, Bangkok, Thailand.