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APPENDIX

Appendix A Raw data of experiment

Table A1 Percentage of calcium compound from eggshell

Sample Weight (g)		Percentage of calcium compound
Before calcinations	After calcinations	
8.03	6.17	77
7.99	6.13	77
8.00	6.13	77
8.03	6.13	76
20.00	15.38	77
8.00	4.56	57
8.02	4.60	57
8.04	4.57	57
8.03	4.50	56
20.08	11.34	56
8.05	4.53	56
8.02	4.53	56
8.00	4.55	57
8.06	4.53	56
15.04	8.46	56
8.06	4.66	58
8.10	4.55	56
8.06	4.51	56
8.10	5.38	66
15.02	8.48	56
17.02	9.50	56
15.09	9.29	62
8.03	4.54	57
20.09	10.08	50
17.17	11.72	68
8.05	4.67	58
8.05	4.69	58
20.00	11.96	60
20.00	11.94	60
15.06	9.15	61
20.05	11.42	57
20.00	11.31	57
15.07	8.54	57
20.10	11.36	57
20.05	11.44	57

Sample Weight (g)		Percentage of calcium compound
Before calcinations	Before calcinations	
15.02	8.53	57
15.05	8.53	57
20.03	11.16	56
20.05	11.19	56
15.08	8.26	55
15.00	8.33	56
20.01	11.30	56
20.20	11.05	55
15.08	8.23	55
15.05	7.74	51
20.00	11.24	56
20.01	11.24	56
15.05	8.35	55
15.06	8.07	54
20.05	11.32	56
20.10	11.49	57
15.00	8.49	57
15.04	8.46	56
20.02	11.31	56
15.00	8.26	55
15.02	8.31	55
15.60	9.39	60
20.67	11.69	57
20.90	11.73	56
15.56	8.74	56
21.57	12.09	56
20.98	11.78	56
15.56	8.94	57
21.57	11.33	53
20.98	11.2	53
20.96	11.2	53
21.79	11.71	54
10.12	6.41	63
15.06	9.47	63
15.17	9.43	62
10.45	5.93	57
15.39	8	52
15.11	7.93	52
10.00	5.59	56
15.08	8.52	56

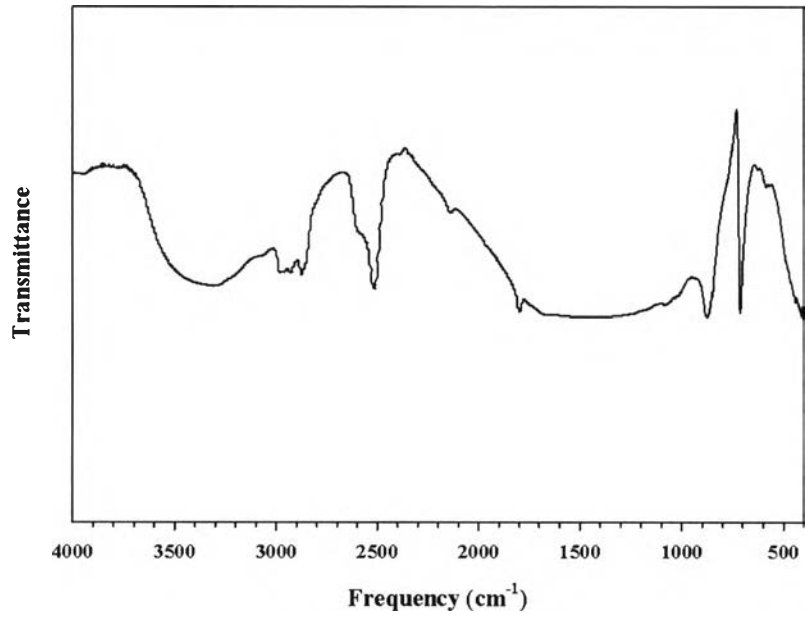

Figure A1. FT-IR spectrum of eggshell.

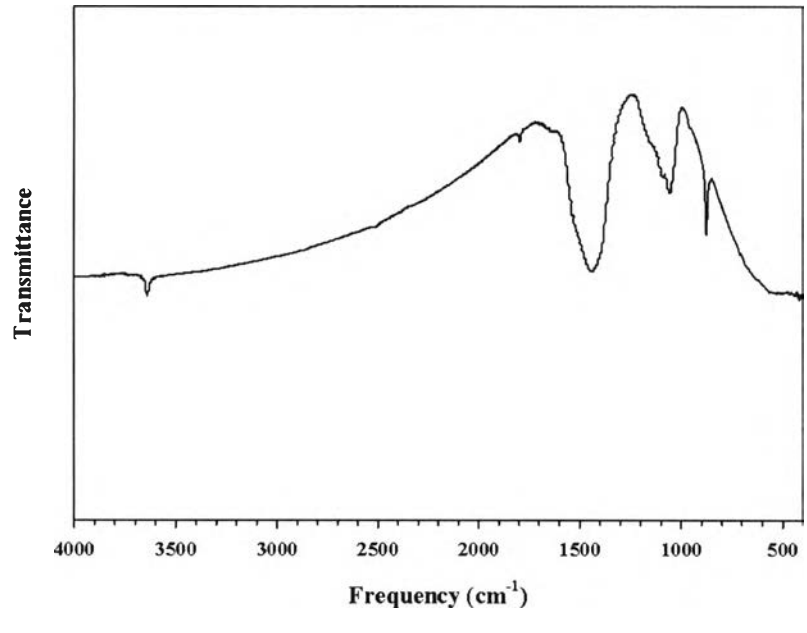

Figure A2. FT-IR spectrum of calcium oxide.

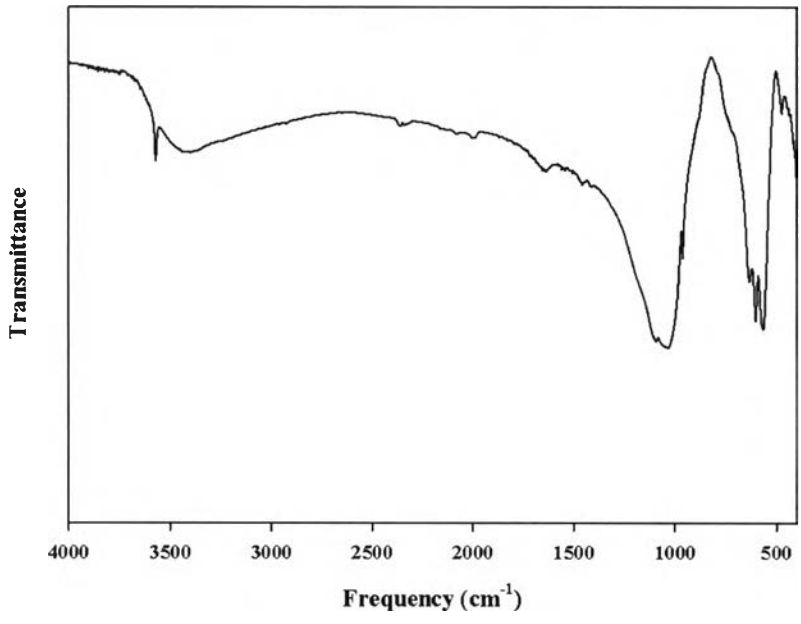

Figure A3. FT-IR spectrum of hydroxyapatite.

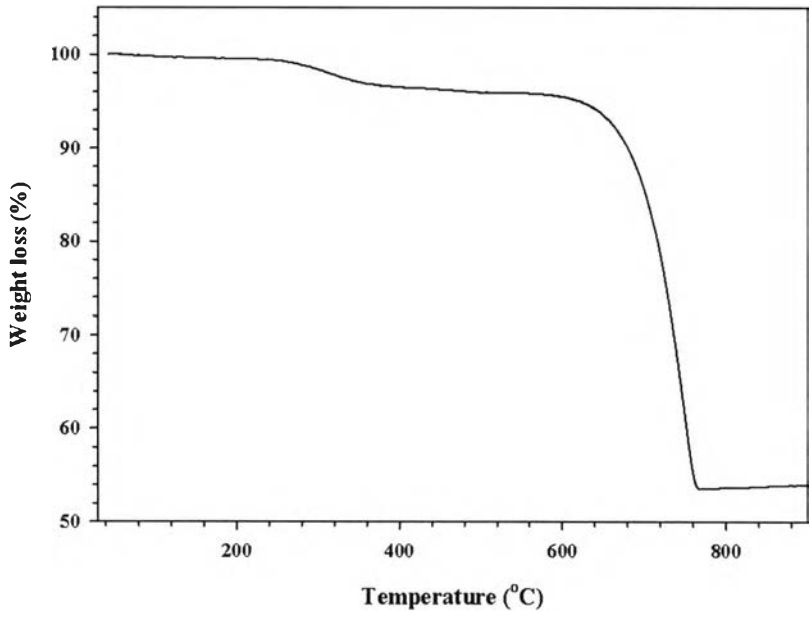

Figure A5. TGA thermogram of eggshell.

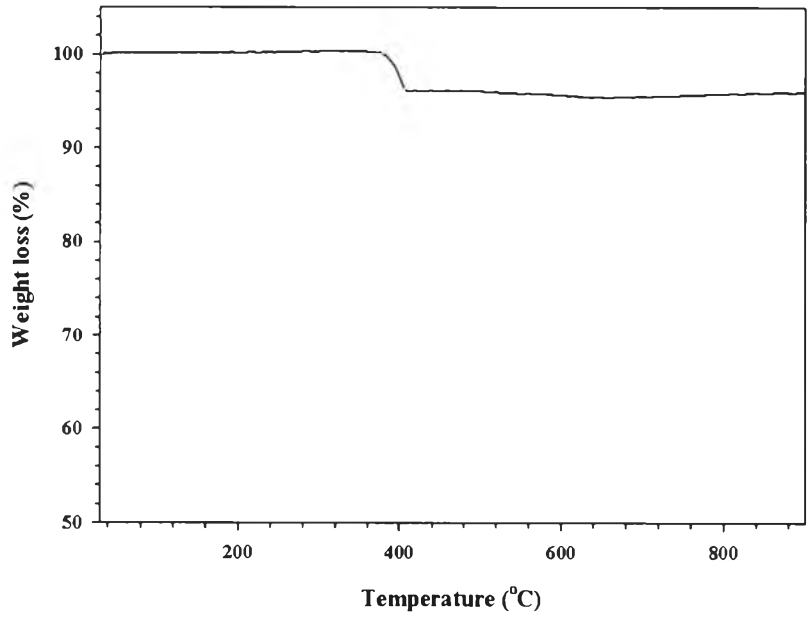

Figure A6. TGA thermogram of calcium oxide.

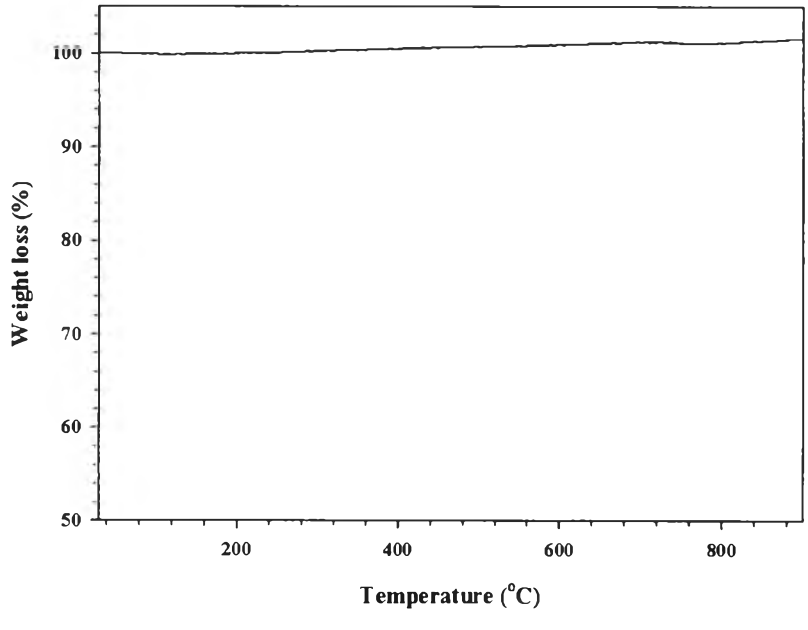

Figure A7. TGA thermogram of hydroxyapatite.

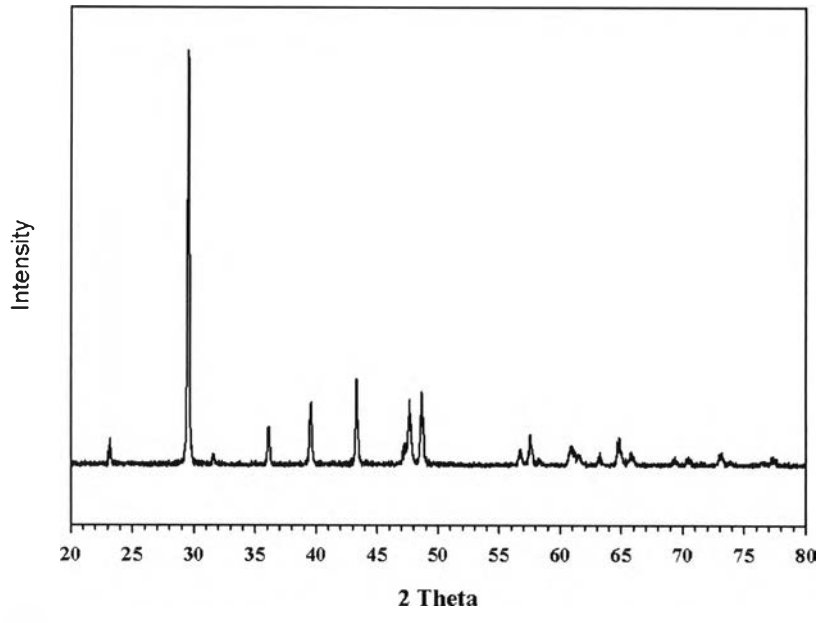

Figure A8. XRD pattern of eggshell.

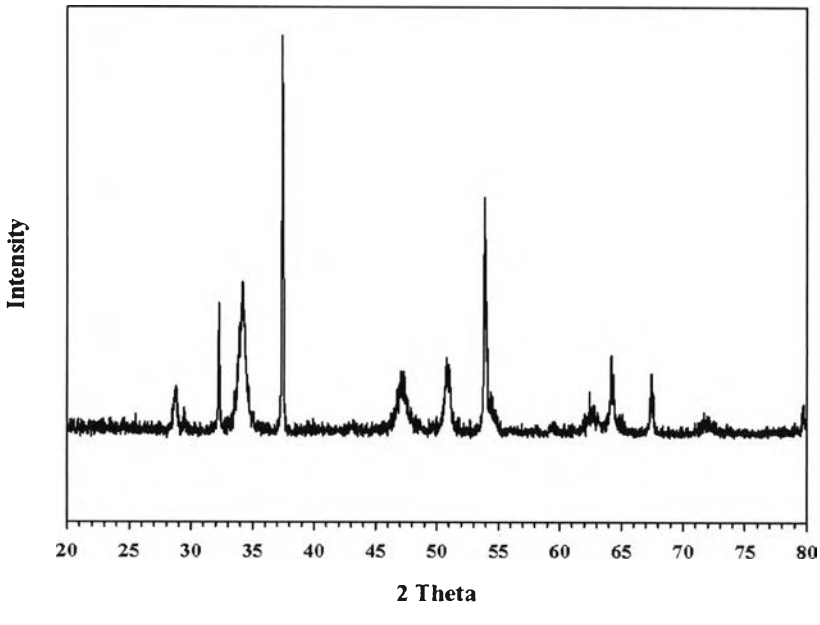

Figure A9. XRD pattern of calcium oxide.

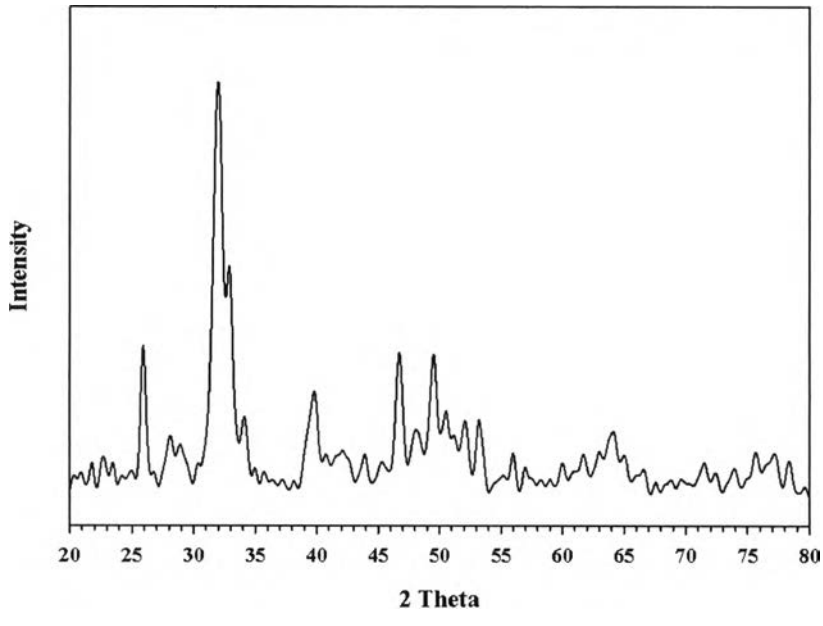

Figure A10. XRD pattern of hydroxyapatite.

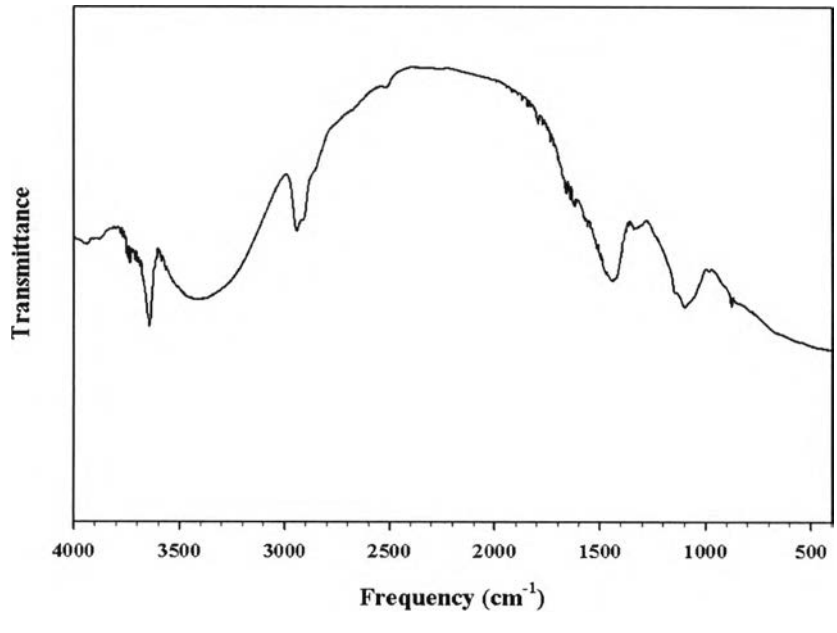

Figure A11. FT-IR spectrum of PVA-CaO hybrid aerogel.

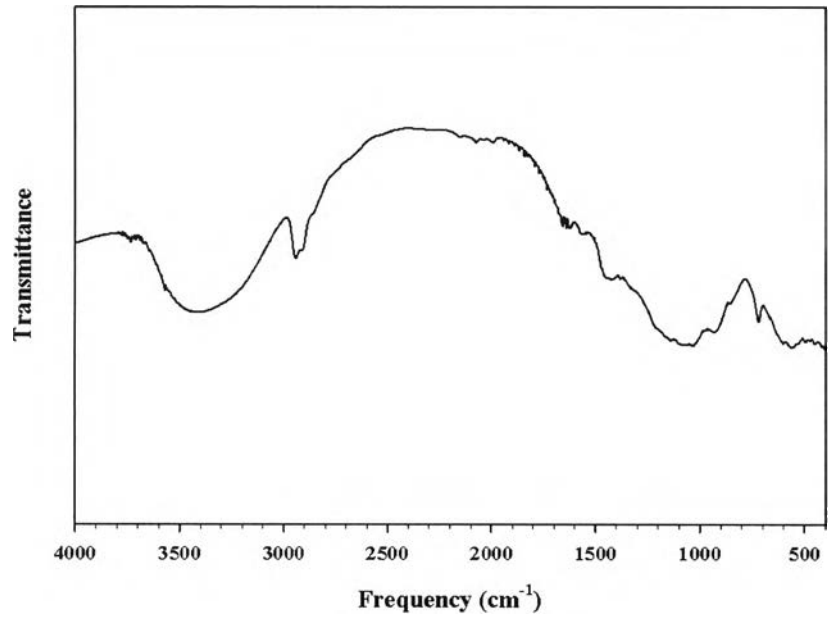

Figure A12. FT-IR spectrum of PVA-HAp hybrid aerogel.

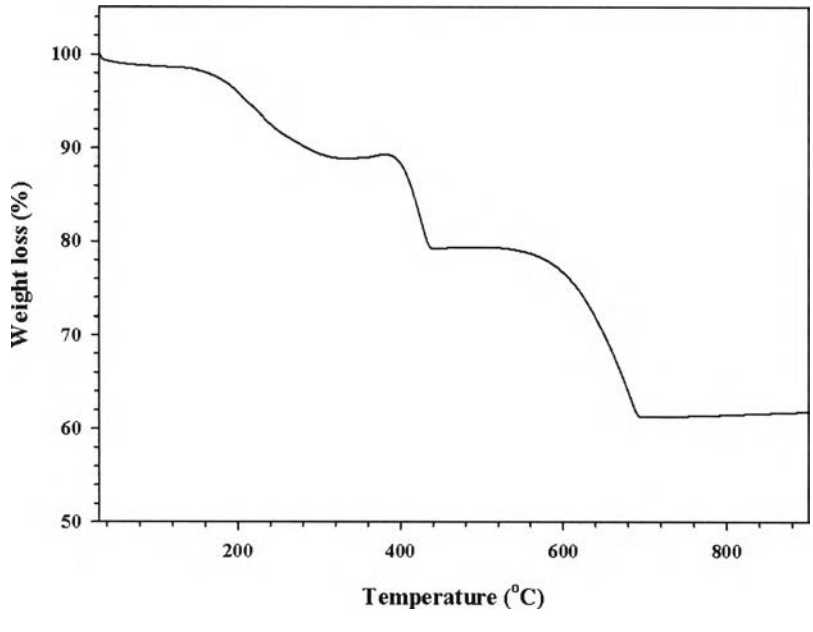

Figure A13. TGA thermogram of 3.0% PVA-CaO hybrid aerogel.

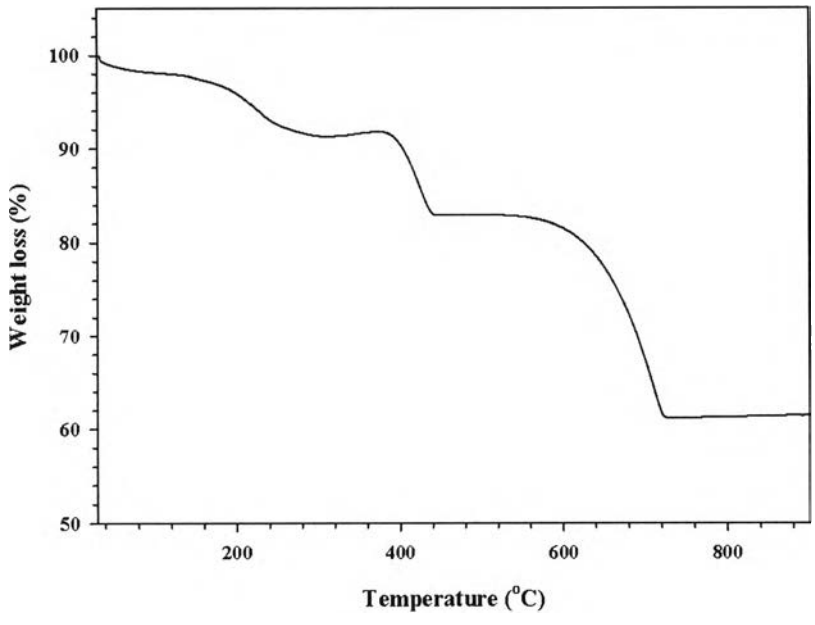

Figure A14. TGA thermogram of 3.5% PVA-CaO hybrid aerogel.

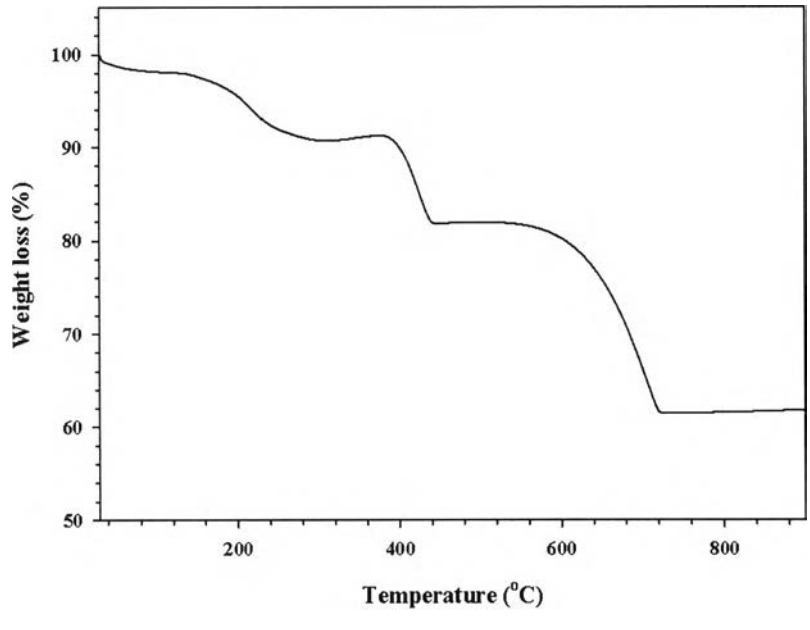

Figure A15. TGA thermogram of 4.0% PVA-CaO hybrid aerogel.

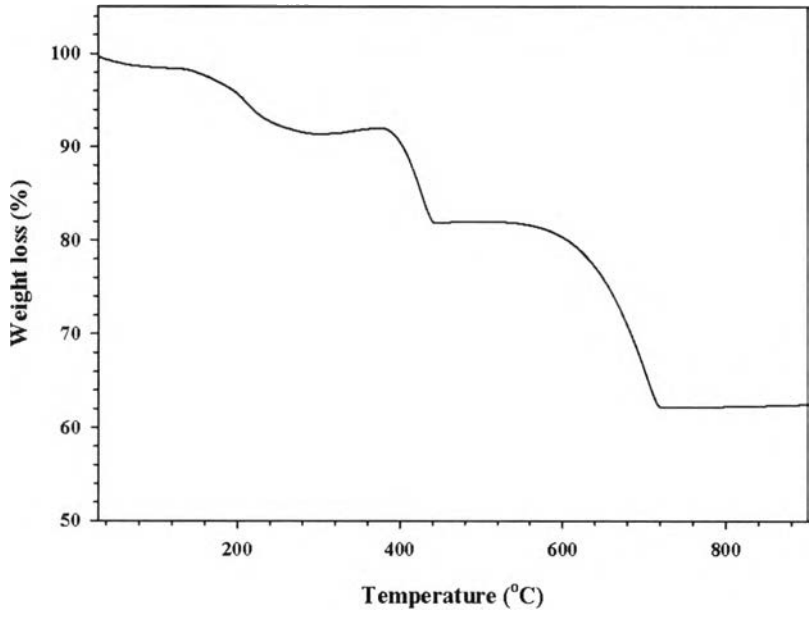

Figure A16. TGA thermogram of 4.5% PVA-CaO hybrid aerogel.

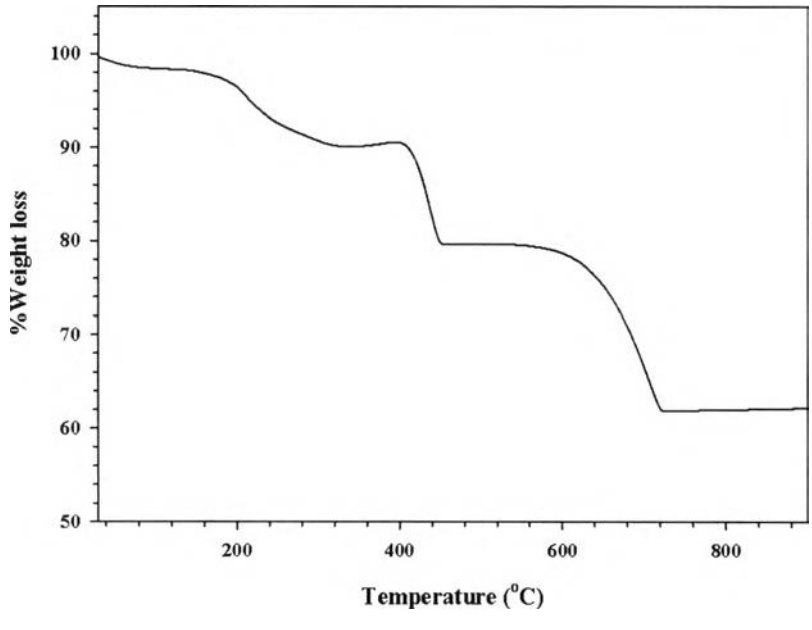

Figure A17. TGA thermogram of 5% PVA-CaO hybrid aerogel.

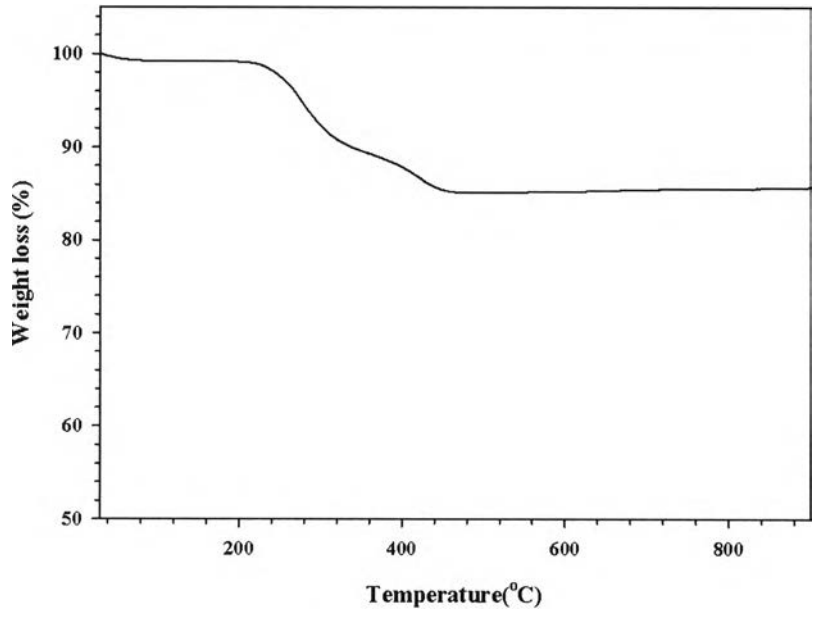

Figure A18. TGA thermogram of 3.0% PVA-HAp hybrid aerogel.

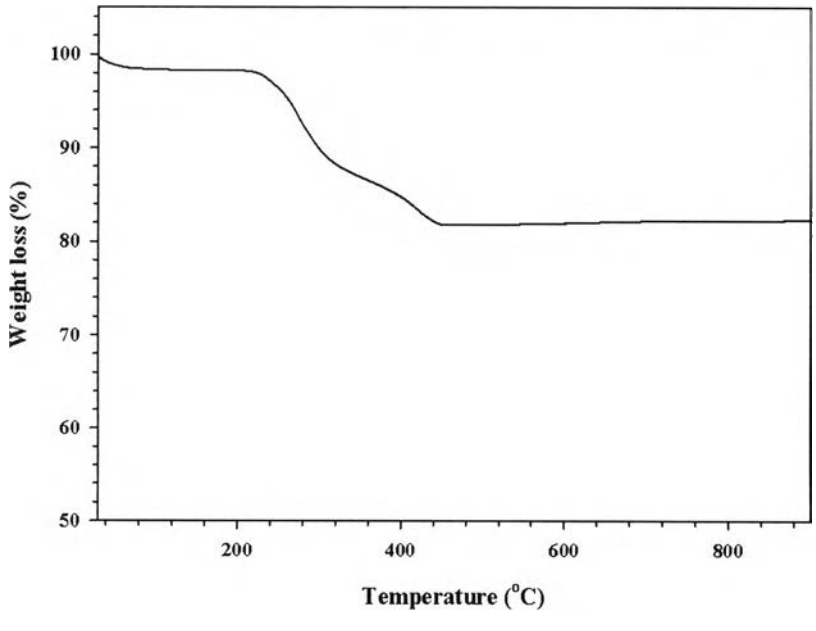

Figure A19. TGA thermogram of 3.5% PVA-HAp hybrid aerogel.

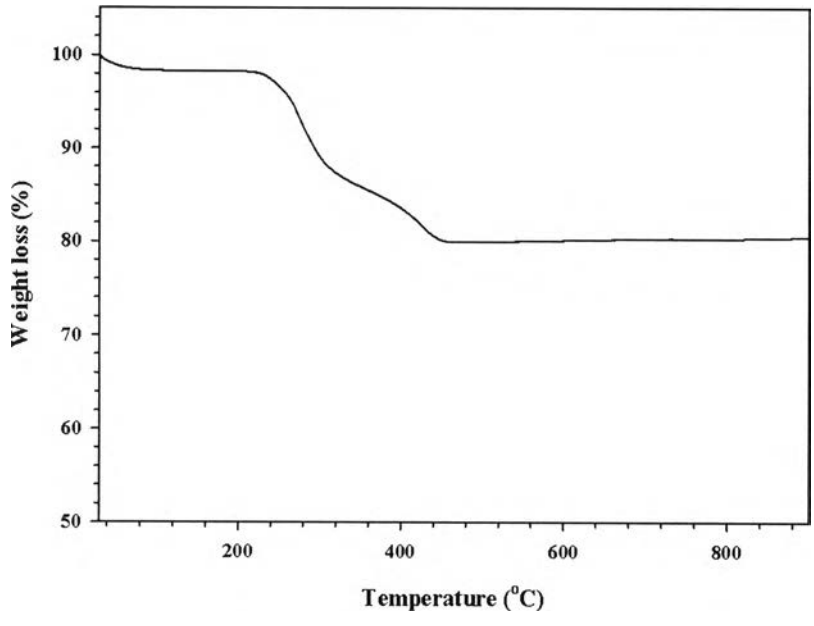

Figure A20. TGA thermogram of 4.0% PVA-HAp hybrid aerogel.

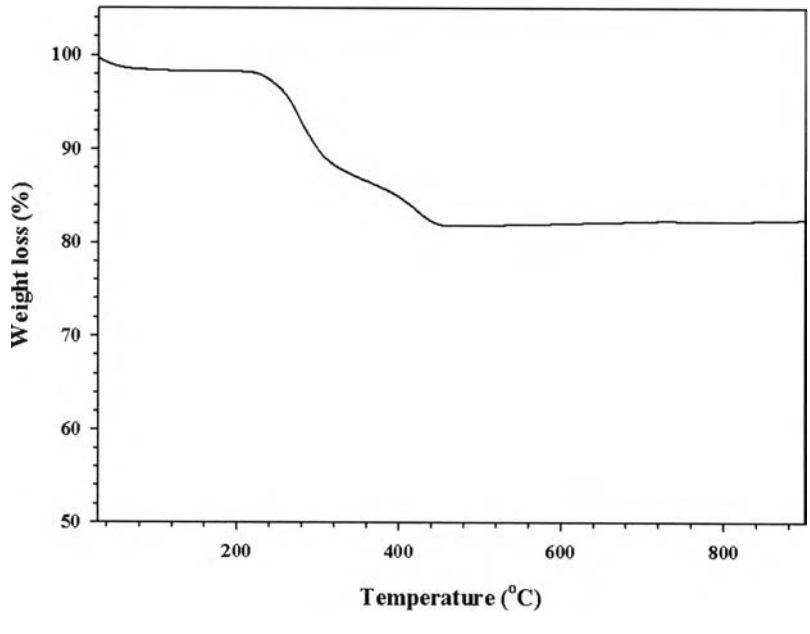

Figure A21. TGA thermogram of 4.5 % PVA-HAp hybrid aerogel.

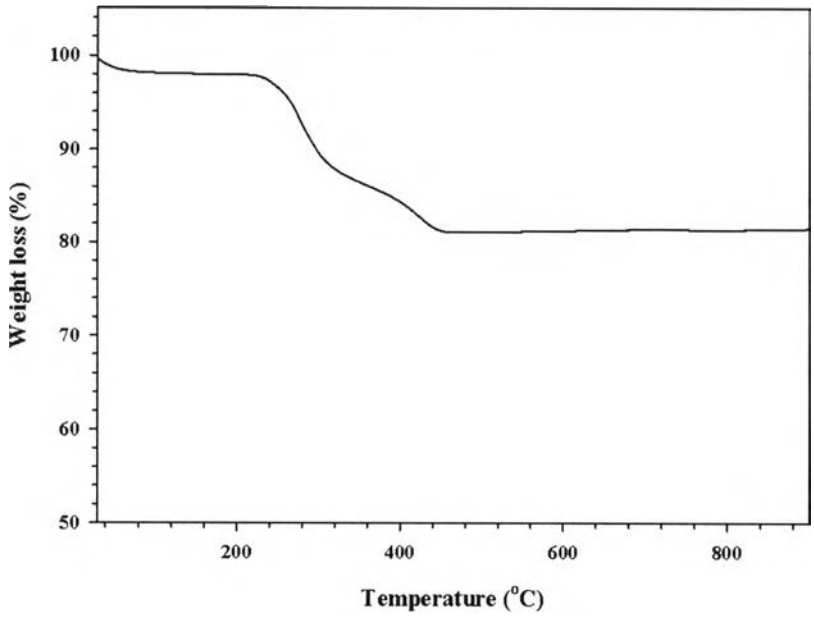

Figure A22. TGA thermogram of 5.0% PVA-HAp hybrid aerogel.

Table A2 Percentage of shrinkage using various ratios of PVA and CaO and different percentages of PVA in water

Weight percentage of PVA in water	PVA:CaO	Percentage of volume shrinkage
3.00	20:80	25.0121±0.6707
	30:70	58.3367±3.7278
	40:60	70.4533±6.2463
4.00	20:80	19.1821±1.3408
	30:70	48.0500±7.5963
	40:60	58.9983±11.2321
4.50	20:80	10.2662±0.7147
	30:70	41.6500±6.8844
	40:60	58.9983±3.1575
5.00	20:80	12.6898±0.7268
	30:70	40.2683±4.7344
	40:60	77.8167±3.7284

Table A3 Percentage of shrinkage, density, and porosity of CaO/HAp-PVA hybrid aerogel using different percentages of PVA in water

Type of calcium compound	Weight percentage of PVA in water	Percentage of volume shrinkage	Density	Percentage of Porosity
CaO	3.00	26.4370±2.5978	0.2669±0.0087	82.2736±0.4700
	3.50	25.9509±4.0907	0.2969±0.0059	82.9153±0.7364
	4.00	23.0465±5.1929	0.3272±0.0137	80.8200±0.6230
	4.50	9.5364±2.7682	0.3578±0.0169	79.2101±0.7340
	5.00	12.3109±2.8148	0.4264±0.017	75.9141±0.4958
HAp	3.00	28.7436±3.4390	0.2165±.0120	87.7210±0.2950
	3.50	21.4065±2.3723	0.2272±0.0092	87.2288±0.5105
	4.00	12.8038±1.8672	0.2534±0.0085	85.3759±0 .3446
	4.50	11.0708±3.2640	0.2813±0.0125	84.3899±0.4488
	5.00	7.8836±1.8869	0.2911±0.0105	82.3877±0.4235

Table A4 Compressive strength of CaO/HAp - PVA hybrid aerogel using different percentages of PVA in water

Type of calcium compound	Weight percentage of PVA in water	Compressive Strength (MPa)	Young's Modulus(KPa)
CaO	3.00	0.7508±0.0355	3916±319
	3.50	1.0505±0.1462	4973±568
	4.00	2.0471±0.1885	10574±1622
	4.50	2.2841±0.2433	10209±1221
	5.00	2.9177±0.1981	11038±1279
HAp	3.00	0.3809±0.0295	1822±259.0
	3.50	0.6684±0.0603	3396±906.6
	4.00	0.7455±0.1346	4067±1023
	4.50	1.2701±0.0559	6764±718.5
	5.00	1.3645±0.1237	7147±691.9

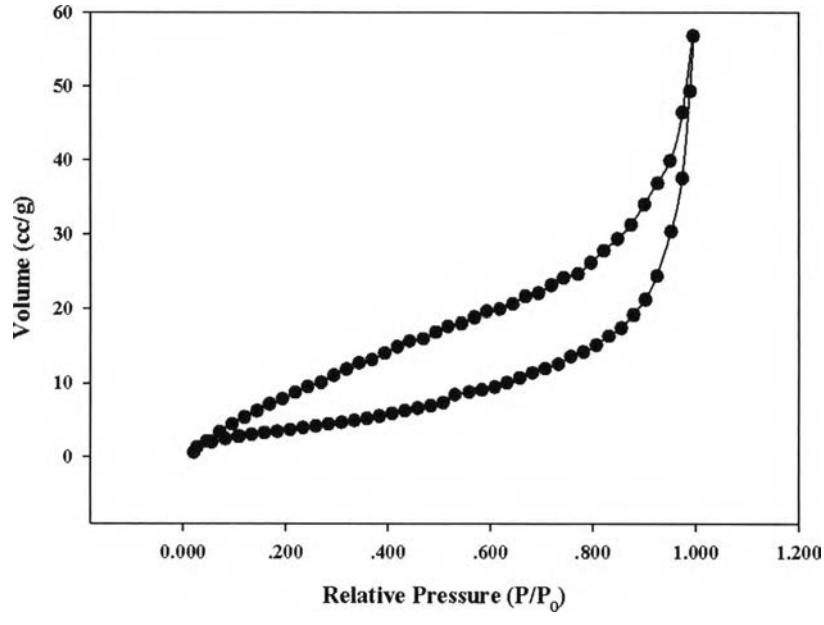

Figure A23. Nitrogen adsorption/desorption isotherms of 3.0 % PVA-CaO hybrid aerogel.

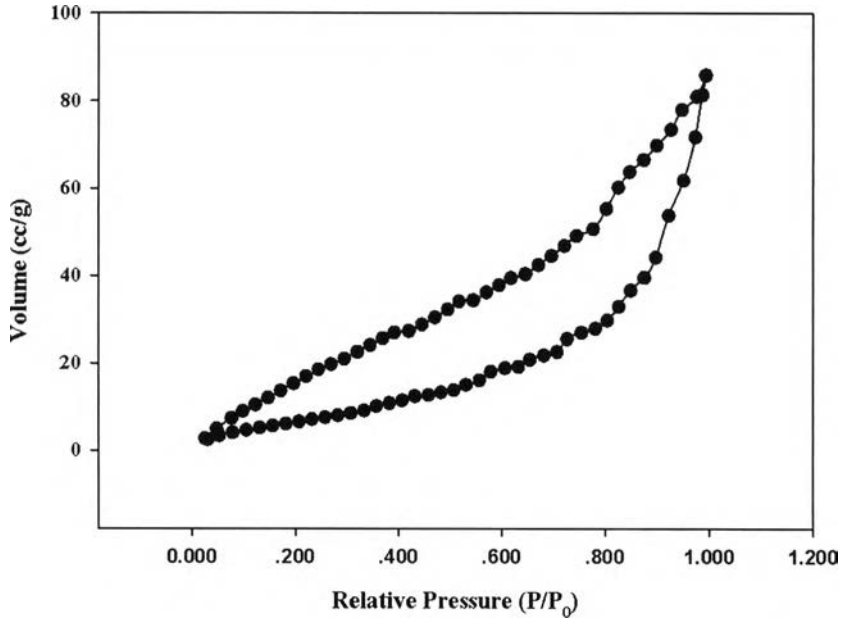

Figure A24. Nitrogen adsorption/desorption isotherms of 3.5 % PVA-CaO hybrid aerogel.

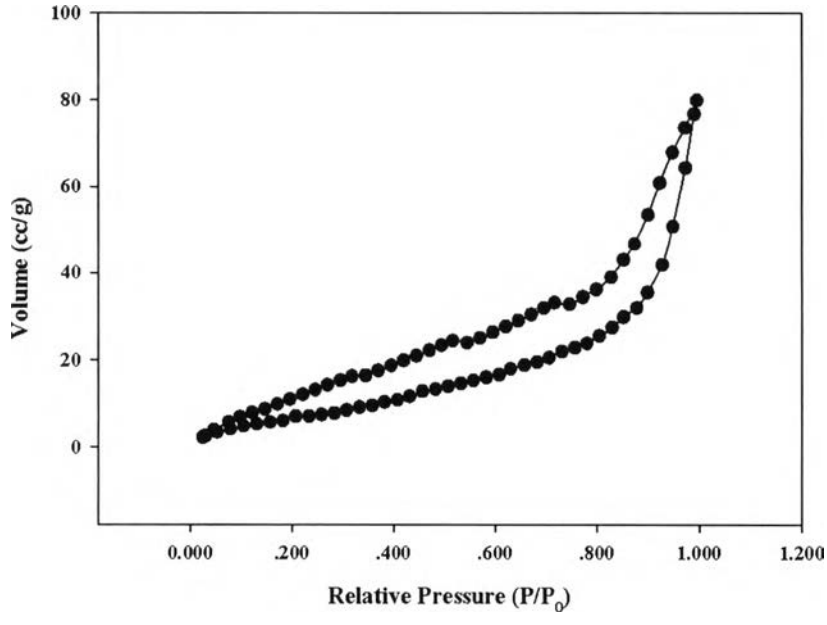

Figure A25. Nitrogen adsorption/desorption isotherms of 4.0 % PVA-CaO hybrid aerogel.

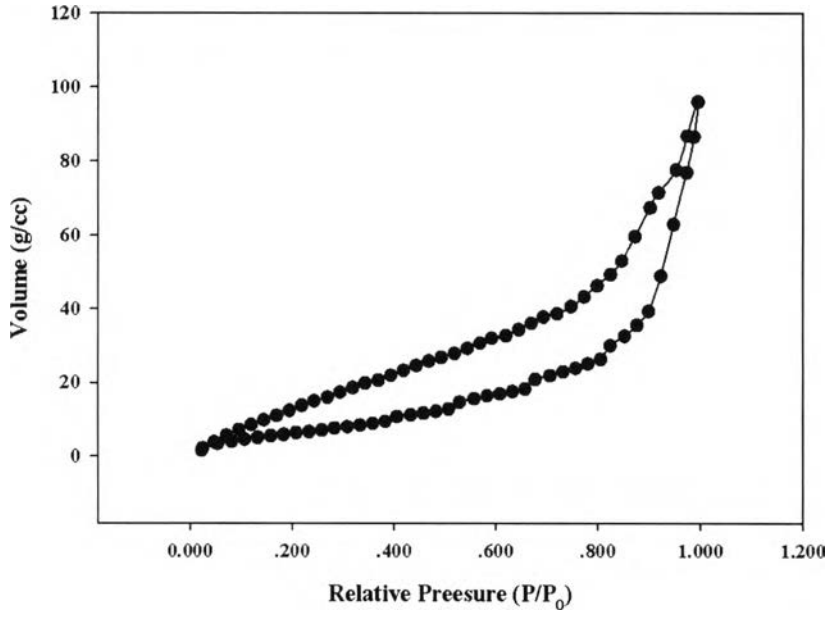

Figure A26. Nitrogen adsorption/desorption isotherms of 4.5 % PVA-CaO hybrid aerogel.

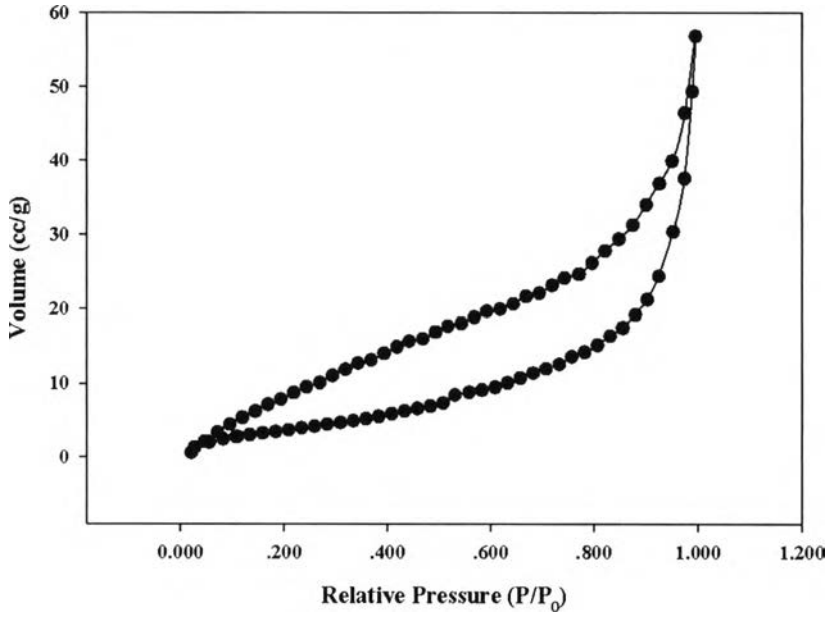

Figure A27. Nitrogen adsorption/desorption isotherms of 5.0 % PVA-CaO hybrid aerogel.

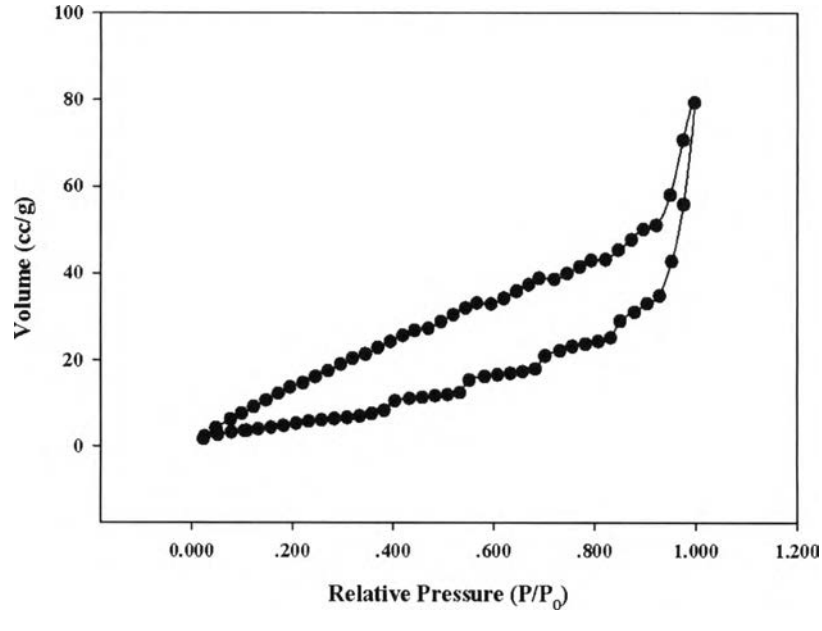

Figure A28. Nitrogen adsorption/desorption isotherms of 3.0 % PVA-HAp hybrid aerogel.

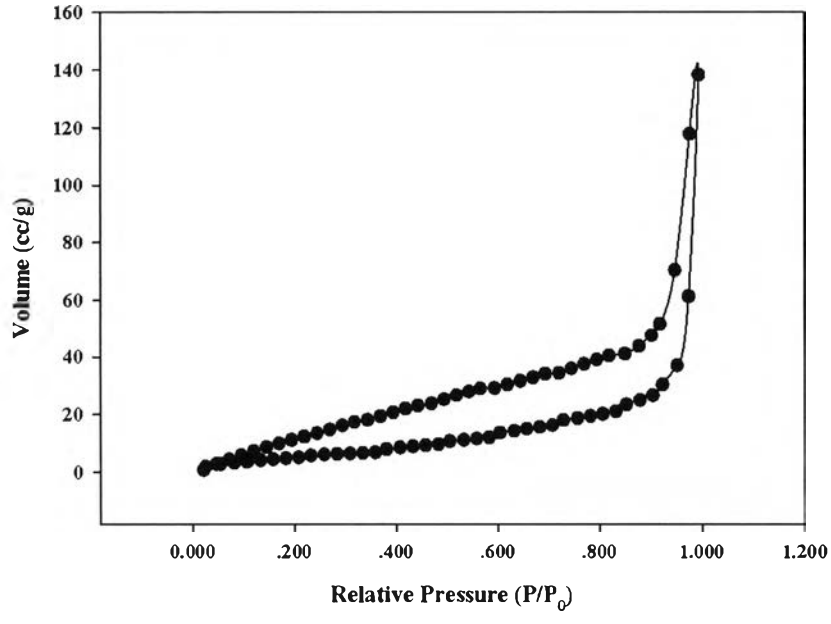

Figure A29. Nitrogen adsorption/desorption isotherms of 3.5 % PVA-HAp hybrid aerogel.

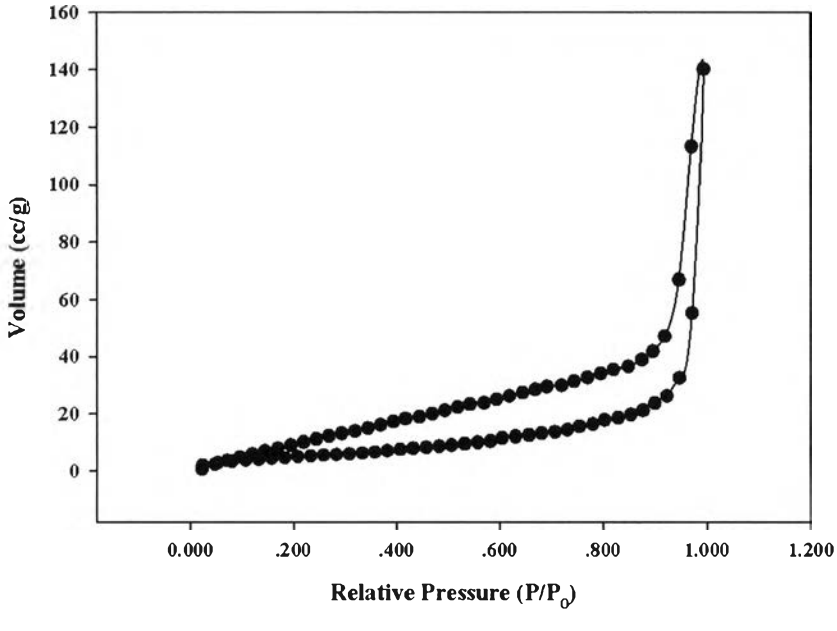

Figure A29. Nitrogen adsorption/desorption isotherms of 4.0 % PVA-HAp hybrid aerogel.

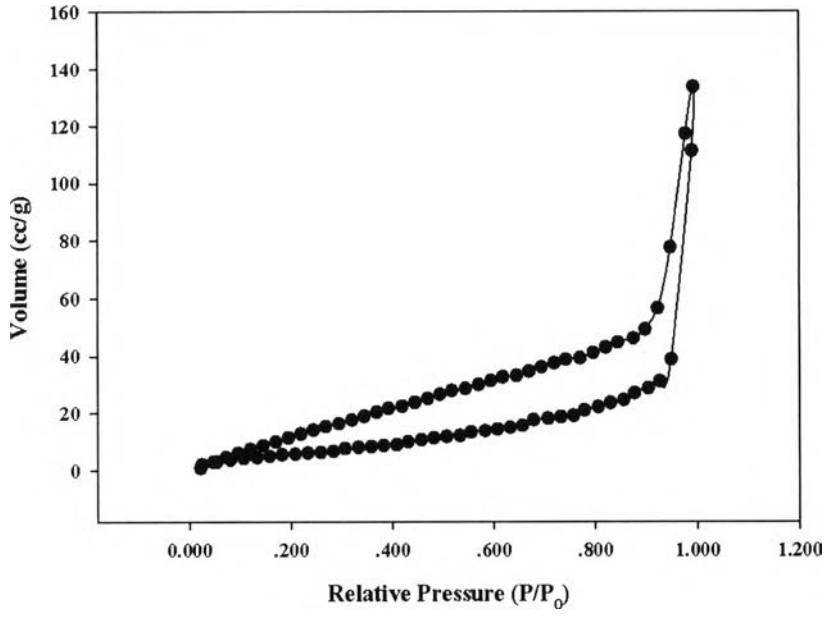

Figure A30. Nitrogen adsorption/desorption isotherms of 4.5 % PVA-HAp hybrid aerogel.

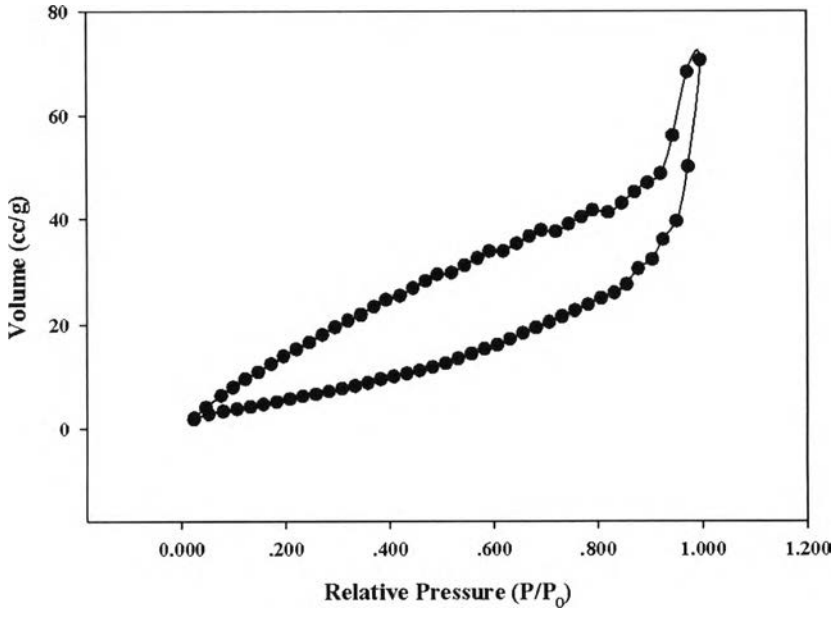

Figure A31. Nitrogen adsorption/desorption isotherms of 5.0 % PVA-HAp hybrid aerogel.

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Proceedings:

1. Chaikul, K., Chaisuwan, T., Schiraldi, D.A., and Wongkasemjit, S. (2013, April 23) Aerogel from Egg Shell for Artificial Bone. Proceedings of the 4rd Research Symposium on Petrochemical and Materials Technology and the 19th PPC Symposium on Petroleum, Petrochemicals, and Polymers, Ballroom, Queen Sirikit National Convention Center, Bangkok, Thailand..

Presentations:

1. Chaikul, K., Chaisuwan, T., Schiraldi, D.A., and Wongkasemjit, S. (2013, January 23-25) Aerogel from Egg Shell for Artificial Bone. Paper presented at Pure and Applied Chemistry International Conference 2013 (PACCON 2013), The Tide Resort, Bangsaen Beach, Chon Buri, Thailand.
2. Chaikul, K., Chaisuwan, T., Schiraldi, D.A., and Wongkasemjit, S. (2013, March 3-7) Aerogel from Egg Shell for Artificial Bone. Paper presented at Third International Conference on Multifunctional, Hybrid and Nanomaterials, The Hilton Sorrento Palace Hotel in Sorrento, Italy