7. Appendices

7.1. Appendix A

7.1.1. Processing temperatures for commercial polymers

Polymer	"Melt" Temperature	Processing Temperature	Mould Temperature
Poly(vinyl chloride) [PVC]	100	195	35
Polyoxymethylene [POM]	180	200	100
Polyurethane [PUR]	160	205	35
Polystyrene [PS]	100	225	45
Polyamide 11 [Nylon 11; PA 11]	175	230	60
Polyamide 12 [Nylon 12; PA 12]	175	230	60
Poly(methyl methacrylate) [PMMA]	100	245	70
Acrylonitrile-Butadiene-Styrene [ABS]	110	250	75
Polyethylene [PE]	140	250	25
Polyamide 6 [Nylon 6; PA 6]	220	250	90
Polyamide 6,10 [Nylon 6,10; PA 6,10]	215	250	90
Polypropylene [PP]	170	255	35
Poly(butylene terephthalate) [PBT]	225	255	35
Styrene-Acrylonitrile [SAN]	115	255	80
Poly(ethylene terephthalate) [PET]	225	280	140
Polyamide 6,6 [Nylon 6,6; PA 6,6]	255	285	90
Polycarbonate [PC]	150	300	90
Polyphenylene oxides [PPO]	120	300	80
Polysulphone [PSU]	200	315	150
Perfluoro(ethylene/propylene) [FEP]	275	315	150
Poly(phenylene sulphide) [PPS]	290	330	110
Polyethersulphone [PES]	230	350	150
Poly(amide imide) [PAI]	300	365	230
Poly(ester imide) [PEI]	215	370	100
Poly(ether ether ketone) [PEEK]	335	370	160
Liquid crystal polymers [LCP]	330	400	175
Units	**°C**	**°C**	**°C**

7.2. Appendix B

7.2.1. Limiting Oxygen Index for commercial polymers

(Van Krevelen, 1990; Lyons, 1987; Hirschler, 2000)

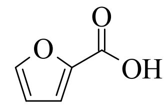
Polymer	**LOI**
Polyformaldehyde	0.15
Poly(ethylene oxide) [PEO]	0.15
Polyoxymethylene [POM]	0.15
Polyacetal	0.16
Kitchen candle	0.16
Poly(methyl methacrylate) [PMMA]	0.17
Styrene-Acrylonitrile [SAN]	0.18
Acrylonitrile-Butadiene-Styrene [ABS]	0.18
Polyacrylonitrile [PAN]	0.18
Polyethylene [PE]	0.18
Polypropylene [PP]	0.18
Polystyrene [PS]	0.19
Polyisoprene	0.19
Polybutadiene	0.19
Cellulose	0.19
Cotton	0.20
Poly(ethylene terephthalate) [PET]	0.21
Air	**0.21**
Poly(vinyl alcohol) [PVA]	0.22
Polyamide 6,6 [Nylon 6,6]	0.23
Penton®	0.23
Wool	0.25
Polyamide 6 [Nylon 6]	0.26
Polycarbonate [PC]	0.27
Nomex®	0.29
Polyphenylene oxides [PPO]	0.29
Polysulphone	0.30
Silicone rubber	0.32
Phenol-formaldehyde resin	0.35
Polyether-ether ketone	0.35
Neoprene®	0.40
Polybenzimidazole	0.42
Poly(vinyl chloride) [PVC]	0.42
Poly(vinylidene fluoride)	0.44
Polyphenylene sulphide	0.44
Poly(vinylidene chloride)	0.60
Carbon	0.60
Poly(tetrafluoroethylene) [PTFE, Teflon®]	0.95

7.3. Appendix C

7.3.1. List and structure of acids (and complexes) used

Compound	Aromatic	Acid groups	Carbons	Hydroxyl groups	Other
		Acids			
α-Fufoic acid = 2-Furan carboxylic acid		1	5		
2-Ketoglutaric acid		2	5		
3,5-Diaminobenzoic acid	*	1	7		2 x NH_2
3-Picolinic acid = Nicotinic acid		1	6		Pyridine
4-*t*-Butylbenzoic acid	*	1	11		
Adipic acid		2	6		
Anisic acid = Methoxybenzoic acid	*	1	8		
Aspartic acid		2	4		NH_2
Azelaic acid		2	9		
Barbital = Barbitone = 5,5-Diethylbarbituric acid			8		2 x NH
Benzoic acid	*	1	7		
Butyric acid		1	4		
Citric acid		3	6	1	
Coumaric acid = 2-Hydroxycinnamic acid	*	1	9	1	
Cyanuric acid = *i*-Cyanuric acid			3	3	3 x N in ring
Decanoic acid = Capric acid		1	10		
Formic acid		1	1		
Galacturonic acid		1	6	4	
Gallic acid	*	1	7	3	
Gluconic acid		1	6	5	
Glutaric acid		2	5		
Glycine = Glycocoll = Aminoacetic acid		1	2		NH_2
Glycolic acid		1	2	1	
Glycolic acid ethyl ether = Ethoxyacetic acid		1	4		
Heptanoic acid = Enanthic acid		1	7		
Hexanoic acid = Caproic acid		1	6		
Homophthalic acid	*	2	9		
i-Butyric acid		1	4		
i-Phthalic acid	*	2	8		
Lauric acid		1	12		
Levukinic acid		1	5		
Maleic acid		2	4		
Malic acid		2	4	1	
Malonic acid		2	3		
Mandelic acid	*	1	8	1	

Compound	**Aromatic**	**Acid groups**	**Carbons**	**Hydroxyl groups**	**Other**
Mucic acid = Galactaric acid		2	6	4	
Myristic acid		1	14		
Nitrillo triacetic acid		3	6		N
Nonanoic acid = Pelargonic acid		1	9		
Octanoic acid = Caprylic acid		1	8		
Oxalic acid		2	2		
Palmitic acid		1	16		
Phenylacetic acid	*	1	8		
Phthalic acid = 1,2-Benzene dicarboxylic acid	*	2	8		
Phthalic anhydride	*	2	8		
Phytic acid		12	6		6 x $H_2PO_4^-$
Pyrazinecarboxylic acid		1	5		Pyrazine
Pyrogallic acid = Pyrogallol	*		6	3	
Pyromellitic acid = 1,2,4,5-Benzene tertacarboxylic acid	*	4	10		
Sebacic acid = Decanedioic acid		2	10		
Sorbic acid		1	6		
Stearic acid		1	18		
Succinic acid		2	4		
Tartaric acid		2	4	2	
Tiglic acid		1	5		
Trimesic acid = 1,3,5-Benzene tricarboxylic acid	*	3	9		
Undecylenic acid		1	11		
Uric acid			5		4 x NH
Sodium complexes					
di-Sodium fumarate		2	4		
di-Sodium oxalate		2	2		
di-Sodium tartrate		2	4	2	
Phenylpyruvic acid sodium salt	*	1	9		
Phytic acid deodeca sodium salt		12	6		6 x $H_2PO_4^-$
Pyruvic acid sodium salt		1	3		
Sodium cyclamate		1	6		$NHSO_3^-$
Sodium glycolate		1	2	1	
Sodium tetraphenyl borate	*	1	24		B
tri-Sodium citrate		3	6	1	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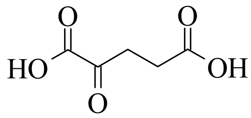
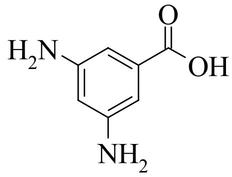
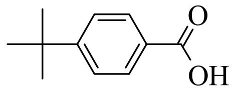
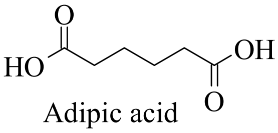

2-Ketoglutaric acid


3,5-Diaminobenzoic acid


4-t-Butylbenzoic acid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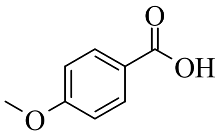
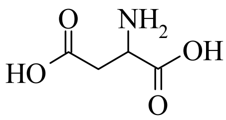

Anisic acid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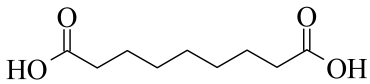
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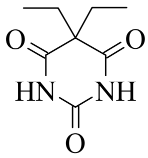
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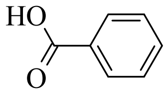
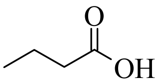

Benzoic acid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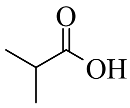
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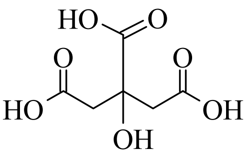
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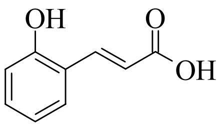
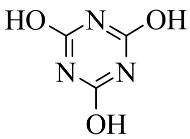

Coumaric acid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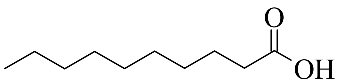
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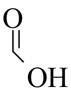
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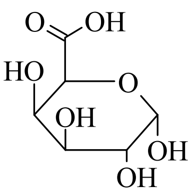
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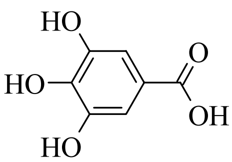
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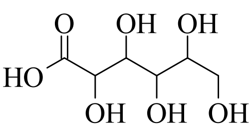
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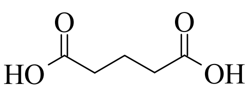
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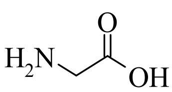
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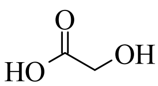
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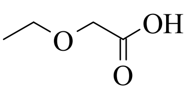
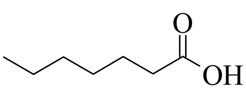

Glycolic acid ethyl ether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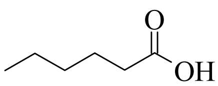
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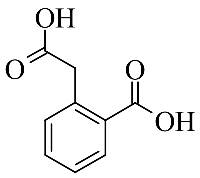
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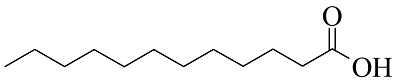
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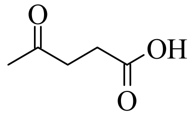
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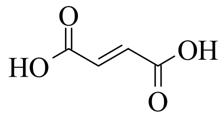
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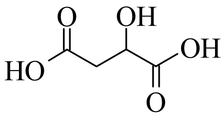
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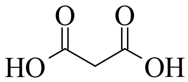
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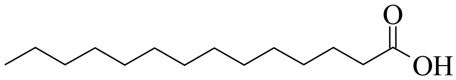
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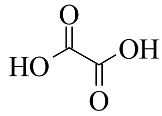
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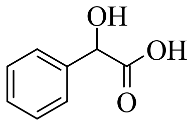
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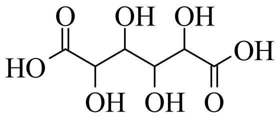
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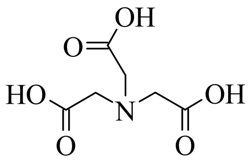
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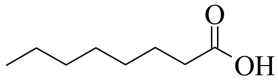
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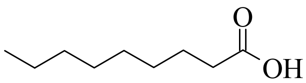
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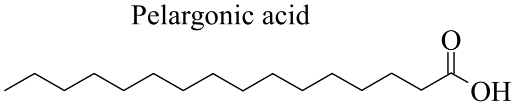
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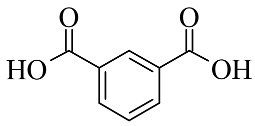
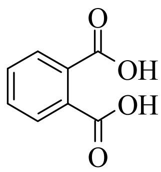

i-Phthalic acid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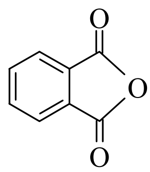
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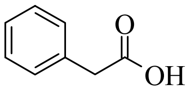
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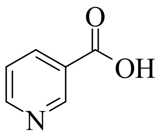
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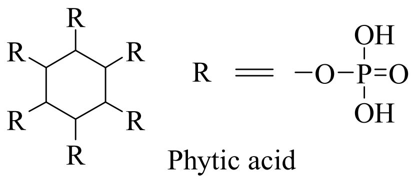
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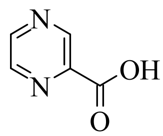
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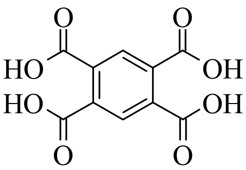
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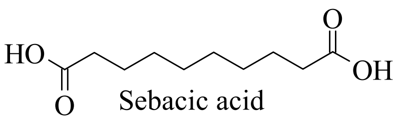
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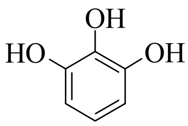
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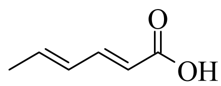
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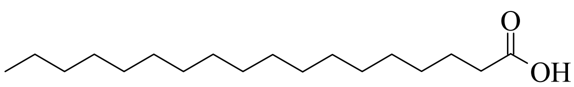
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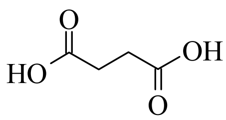
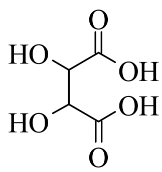
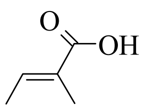
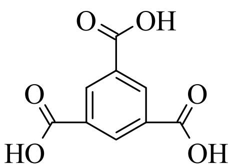
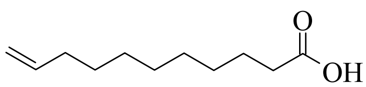
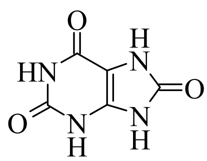

Succinic acid

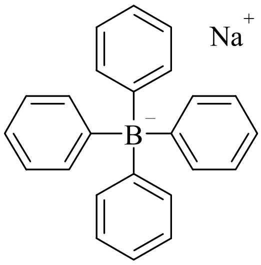

Tartaric acid


Tiglic acid

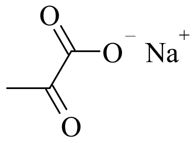

Trimesic acid


Undecylenic acid

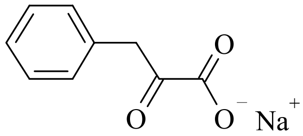

Uric acid



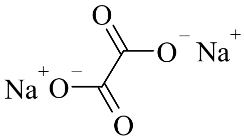
sodium tetraphenyl borate



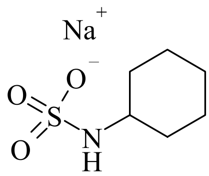
pyruvic acid sodium salt



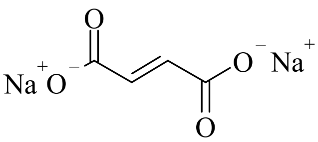
phenylpyruvic acid sodium salt



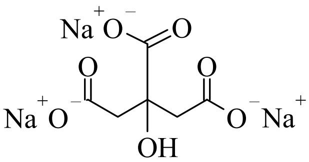
di-sodium oxalate



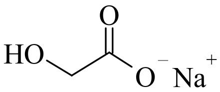
sodium cyclamate



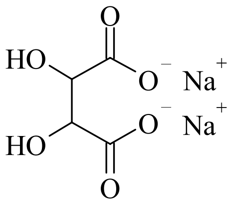
di-sodium fumarate



tri-sodium citrate



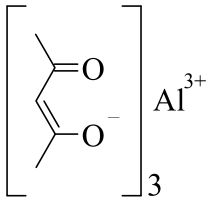
sodium glycolate



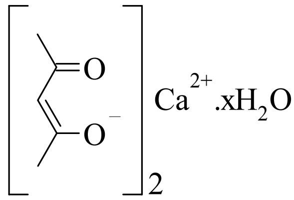
di-sodium tartrate

7.4. Appendix D

7.4.1. Acetylacetonate complexes used

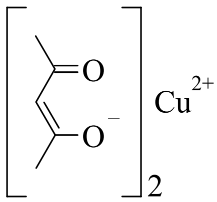


Aluminium acetylacetonate

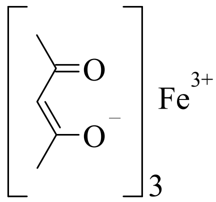


x calculated as 0.7

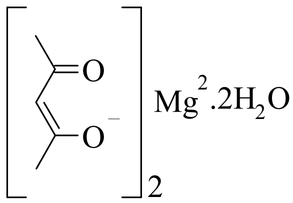
Calcium acetylacetonate



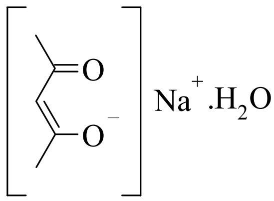
Copper (II) acetylacetonate



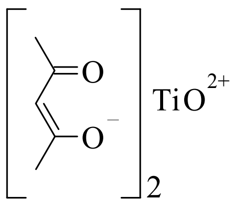
Iron (III) acetylacetonate



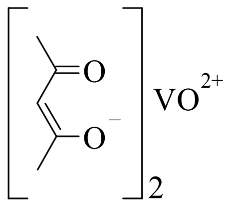
Magnesium acetylacetonate



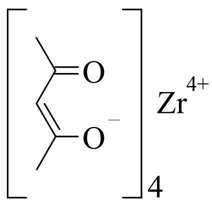
Sodium acetylacetonate



Titanyl acetylacetonate



Vanadyl acetylacetonate



Zirconium acetylacetonate

7.5. Appendix E

7.5.1. The commercial preparation of gluconic acid and its derivatives

Calcium gluconate is mass-produced by the neutralisation of gluconic acid with calcium carbonate. For the production of calcium gluconate, it is easiest to first produce gluconic acid and then neutralise with calcium carbonate (Green, 1980; Theander, 1980; Hustede *et al.,* 1988).

There are several ways to produce gluconic acid commercially. All have to do with the oxidation of glucose (dextrose) or glucose solutions to gluconic acid. **Chemical and electrochemical oxidation** has been used in industry before, but is costly and has relative low yields. Gluconic acid cannot be prepared through photochemical oxidation. The preferred method for the production of gluconic acid is through **biochemical oxidation** (Green, 1980; Theander, 1980; Hustede *et al.,* 1988).

The **catalytic oxidation** of glucose is being used in industry more readily in recent years. Glucose solutions of concentration of 1-2 mol/ℓ is oxidised with oxygen or air while the solution's pH is kept between 8 and 11 (preferably 9-10) with the continuous addition of an alkaline (calcium carbonate) solution. Normally highly purified glucose solutions should be used. The catalysts are platinum-group metals suspended on activated charcoal or aluminium oxide. The effectiveness of the catalysts can be improved by doping the platinum-group metals with lead, selenium, thallium or bismuth, with the preferred carrier being activated charcoal. Typical operation temperatures are 50°C. Catalyst activity, selectivity, lifetime and cost are the most important economical aspects (Green, 1980; Theander, 1980; Hustede *et al.,* 1988).

Chemical oxidation of D-glucose to D-gluconic acid with halogens (and especially chlorine) is known since the second half of the 19th century. Yields are relatively low but can be dramatically increased (up to ~ 96%) with the addition of a solid buffer. The gluconic acid is usually isolated as its calcium salt (Green, 1980).

The principal organisms employed for the **biochemical oxidation** are *Aspergillus niger* and *Gluconobacter suboxydans*, with the *Aspergillus niger* process being used most regularly. For example, typical production parameters for the fermentative synthesis of sodium gluconate with *Aspergillus niger* are (Hustede *et al.,* 1988):

Typical substrate formulation: 250-300 g/ℓ glucose, 0.2-0.3 g/ℓ $MgSO_4.7H_2O$, 0.2-0.3 g/ℓ KH_2PO_4 and 0.4-0.5 g/ℓ $(NH_4)_2HPO_4$ or urea. The substrate must be sterilised. Sterilisation may be done either in batches at 110°C with a residence time of 45 min or continuously under conditions providing several minutes exposure to a temperature of 135-150°C. In the fermentation vessel, the pH is adjusted to 4.5-5.0 and inoculated with the cultured micro-organism. During the production phase, the temperature is maintained at 30-32°C and pH at 5.5-6.5 through continuous neutralisation. The optimum pH for the process is near 5.6. A 30-50% sodium hydroxide solution is used for the neutralisation. Fermentation continues for a period of 40-100 h, depending on the starting concentration. To ensure yields above 80%, an adequate oxygen supply (0.1 ℓ oxygen per ℓ solution per minute) must be maintained. Gas distribution within the fermentor must be optimised. The partial pressure of oxygen may be increased by using oxygen-enriched air or operating the fermentor at elevated pressures.

The cultured medium contains only about 100 g/ℓ glucose, but as much as twice the mentioned amounts of nutrient salts, an increased amount of nitrogen compounds and a 0.2-0.4 g/ℓ corn steep powder (a growth-stimulating additive). A lyophilized permanent culture is used to grow the conidia. The culture is first activated with a specific growth medium in culture tubes. After the production of several subcultures, the organism is introduced into a special medium that encourages the formation of conidia. The conidia are harvested after a 5-10 days incubation period and used to inoculate the preculture.

For the production of calcium gluconate, calcium carbonate may be used for neutralisation instead of sodium hydroxide. The micro-organisms are removed by filtration after fermentation. The product may be decolourised with activated carbon and then either evaporated or crystallised or spray dried.

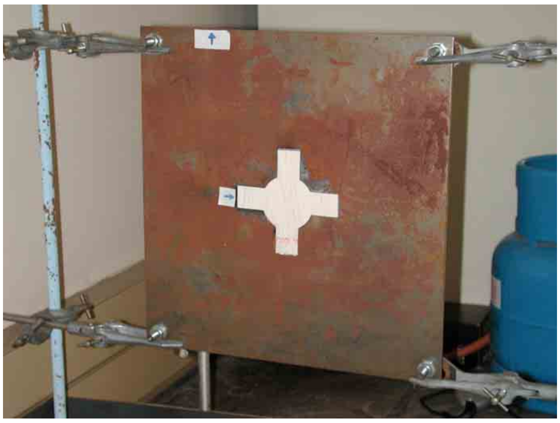
7.6. Appendix F

7.6.1. Vitamin supplement label

7.7. Appendix G

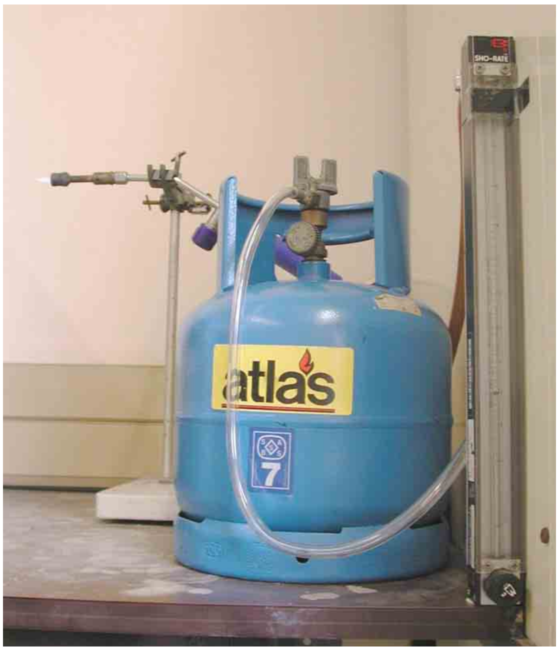
7.7.1. Pictures of the burn test setup

Front view of the setup



Rear view of the setup (no thermocouples)

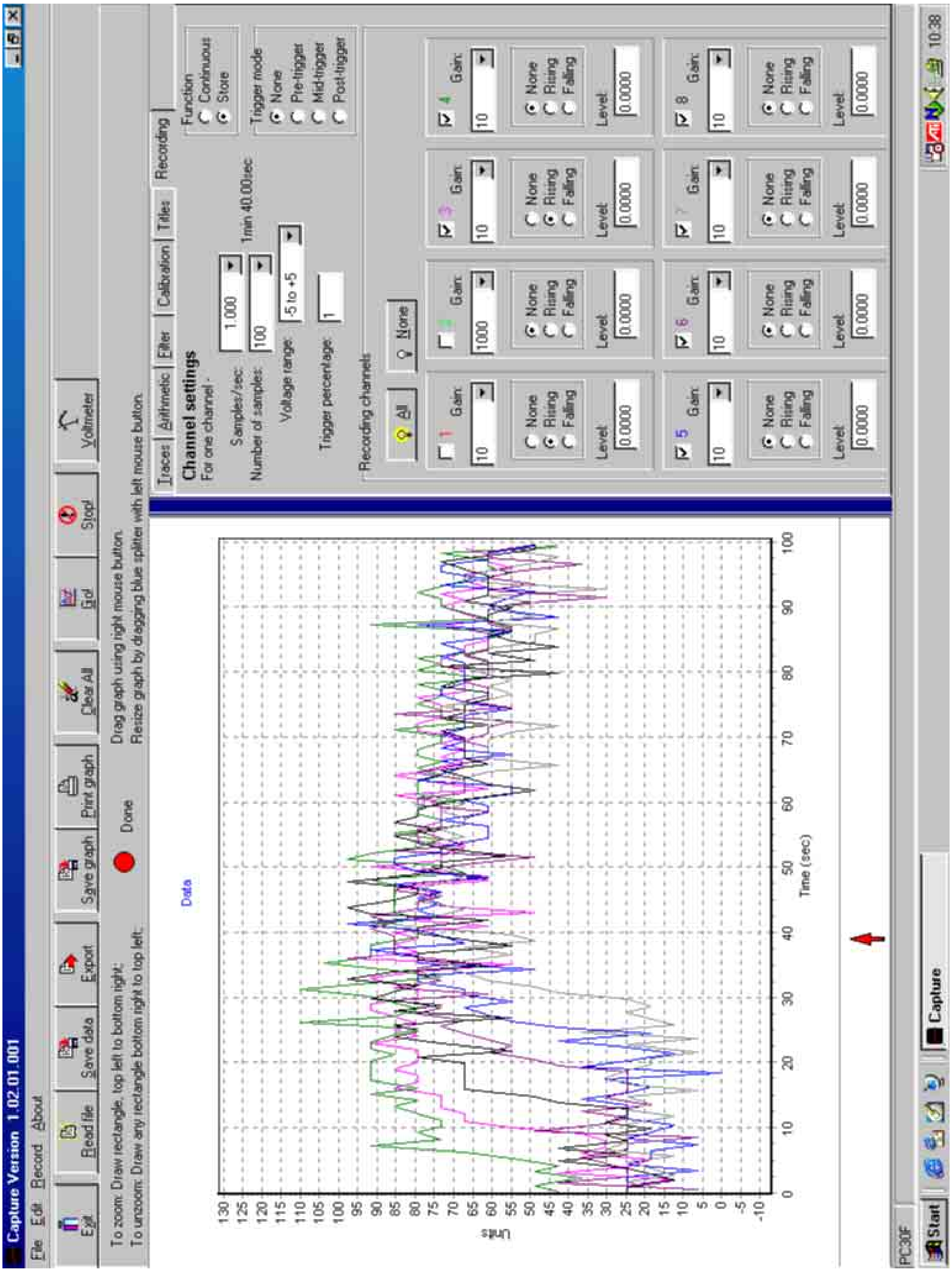
Flame nozzle



Gas bottle and rotameter

7.8. Appendix H

7.8.1. Screen grab of the data logging software, "Capture".



7.9. Appendix I

7.9.1. Photos of the cold finger used for the sublimation crystallisation

7.10. Appendix J

7.10.1. Elemental analysis of the leached SiO_2 from Foskor Pty. Ltd.

SET POINT LABORATORIES
INC. BERGSTROM & BAKKER, GOLDLABS AND ROCKLABS

SET POINT TECHNOLOGY

ANALYSIS REPORT

Attention: Mr Johan Labuschagne
Company: University of Pretoria
Order No: 16318/77
Address: Lynnwoodweg
Pretoria

SPL Report No: 0/1063
Date: 18/5/2000

SAMPLE NAME	Fe2O3 %	MnO %	Cr2O3 %	V2O5 %	TiO2 %	CaO %	K2O %	P2O5 %	SiO2 %	Al2O3 %	MgO %	Na2O %	CL %	M.CH %	S %
SiO2	1.36	0.03	0.02	0	0.15	3.54	1.01	0.06	72.3	1.2	2.7	0.1	0	-15	2.33

Dr CJ Rademeyer
(Divisional Director)

Margaret Farrell
(Analyst)

While every effort is made to provide analysis of the highest accuracy, the liability of **Set Point Laboratories** is restricted to the cost of the analysis

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Internet: www.setpoint.co.za

7.11. Appendix K

7.11.1. Preparation of CaDex (Venter, 2000)

METHOD OF PREPARATION OF CADEX

REACTANTS.

(a) 50.00 g of dextrose monohydrate
(b) 75.00 g of distilled water
(c) 13.84 g of calcium hydroxide powder

METHOD:

1. On a heater/stirrer prepare a solution of the dextrose monohydrate in the water. The water has to be heated slightly. (Time necessary: ± 20 minutes).

2. Put this solution in a 250 ml round bottom flask with three openings. Add about 10 glass boiling stones. Fit a thermometer in one of the openings. Fit two running water coolers, one on top of the other one, to the central opening. Close the third opening with a glass stopper. Heat the solution on a water bath to 60°C.

3. When the solution has reached 60°C add the calcium hydroxide powder through the free opening in the flask with the aid of a funnel.

4. Keep the reaction mixture at 60°C for 20 minutes. Stir the round bottom flask from time to time. The solution immediately turns yellow brown, and later red brown.

5. After twenty minutes remove the round bottom flask from the water bath, and filter the solution with a Buchner filter.

6. The brown liquid filtrate (Cadex) should be stored.

7. Determination of the calcium content of the liquid (Cadex): Add 1 mole of oxalic acid per mole of calcium hydroxide used initially (± 17 g) to 10g of concentrated Cadex solution, as well as about 400 g of distilled water. Stir the solution for about 30 minutes on a heater/stirrer. Filter the suspension (calcium oxalate) through a Buchner filter. Dry the dry filtrate on the filter paper in an oven at about 60°C. Determine the mass of the dry calcium oxalate. Burn 1.00g of calcium oxalate in an oven at 1050°C for about 12 hours. Determine the mass of the resulting calcium oxide powder. Correct the calcium content of the concentrated Cadex solution. (It should contain more or less 4% - 5% calcium.)

8. Add the required amount of distilled water to the concentrated solution

of Cadex to adjust the calcium concentration to the required level (usually about 1%).

METHOD OF PREPARATION OF CAFOR

REACTANTS:

(a) 1.00 g of dextrose monohydrate
(b) 124.00 g of 37% aqueous formaldehyde solution
(c) 13.84 g of calcium hydroxide powder

METHOD:

Follow the same procedure as for preparing Cadex. The starting solution will have 1.00g of dextrose monohydrate and 124.00g of 37% aqueous formaldehyde solution. Work in a fume cupboard when heating the solution. Before the condensation reaction begins there will be an induction period of 5 to 6 minutes during which the temperature of the reaction mixture will rise to about 75°C to 80°C. Make sure that the two Liebig coolers function! The rest of the procedure is as described above.

NB: During each reaction period one obtains about 130 g of product. The reaction has to be repeated several times to prepare bigger amounts of the product.

7.12. Appendix L

7.12.1. Tabulated results for the pyrolysis of the sodium compounds and the synthesis and pyrolysis of the sodium salts

Synthesis	No	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	
Acid H		1	2	1	1	12	2	2	1	1	3	mole
% Na in product		11.261	34.313	6.718	20.892	29.863	19.984	28.730	11.425	13.283	26.725	%
Tube mass		8.860	8.880	8.970	7.210	8.970	7.050	7.240	7.150	7.070	6.880	g
Sample mass	*Before*	0.200	0.670	0.200	0.120	0.340	0.100	0.150	0.160	0.100	0.100	g
Height powder		20	15	12	5	12	3	5	6	4	3	mm
Mass Na in		0.023	0.230	0.013	0.025	0.102	0.020	0.043	0.018	0.013	0.027	g
Total mass	*After*	8.970	9.500	9.100	7.280	9.210	7.100	7.360	7.220	7.130	6.950	g
Height char		41	17	12	61	38	17	27	7	14	40	mm
Mass left (total)		0.110	0.620	0.130	0.070	0.240	0.050	0.120	0.070	0.060	0.070	g
Mass left (Na)		0.023	0.230	0.013	0.025	0.102	0.020	0.043	0.018	0.013	0.027	g
Mass left (Na_2CO_3)		0.052	0.530	0.031	0.058	0.234	0.046	0.099	0.042	0.031	0.062	g
Mass left (carbon)		0.058	0.090	0.099	0.012	0.006	0.004	0.021	0.028	0.029	0.008	g
% carbon left		52.804	14.524	76.176	17.440	2.479	7.867	17.216	39.801	48.969	11.992	%
Height change		21	2	0	56	26	14	22	1	10	37	mm

Synthesis	No		1	2	3	47	4	5	6	7	29	8	9	10	
	Acid	Na_2CO_3	Octanoic	n-Heptanoic	Pelargonic	Nonanoic	Formic	i-Butyric	2-Furoic	Oxalic	Oxalic	Citric	Decanoic	Lauric	
	M_w	105.99	144.22	130.19	158.23	158.24	46.03	88.11	112.09	126.07	126.07	210.14	172.27	200.32	g/mol
Mass acid	*Calculated*		2.00	2.00	2.00	2.00	0.85	1.00	2.00	2.00	2.00	2.00	2.00	2.00	g
Mole acid			0.014	0.015	0.013	0.013	0.018	0.011	0.018	0.016	0.016	0.010	0.012	0.010	mole
Acid H			1	1	1	1	1	1	1	2	2	3	1	1	mole
Mass Na_2CO_3			1.470	1.628	1.340	1.340	1.957	1.203	1.891	1.681	1.681	1.009	1.231	1.058	g
Mole Na_2CO_3			0.014	0.015	0.013	0.013	0.018	0.011	0.018	0.016	0.016	0.010	0.012	0.010	mole
Mass acid	*In*		2.020	2.000	2.020	2.020	1.010	1.000	2.010	2.000	2.000	2.010	2.020	2.010	g
Mole acid			0.014	0.015	0.013	0.013	0.022	0.011	0.018	0.016	0.016	0.010	0.012	0.010	mole
Mass Na_2CO_3 (sol)			29.440	32.560	26.810	26.820	39.450	24.060	37.830	33.650	33.640	20.180	24.620	21.170	g
Mass Na_2CO_3			1.472	1.628	1.341	1.341	1.973	1.203	1.892	1.683	1.682	1.009	1.231	1.059	g
Mole Na_2CO_3			0.014	0.015	0.013	0.013	0.019	0.011	0.018	0.016	0.016	0.010	0.012	0.010	mole
Mole Na			0.028	0.031	0.025	0.025	0.037	0.023	0.036	0.032	0.032	0.019	0.023	0.020	mole
Mass Na			0.639	0.706	0.582	0.582	0.856	0.522	0.821	0.730	0.730	0.438	0.534	0.459	g
Mass expected	**Product**		3.058	3.152	2.965	2.965	2.302	1.851	3.345	2.699	2.698	2.426	2.887	2.757	g
Mass obtained	*Out*		3.730	3.100	3.570	3.220	2.730	2.120	4.710	1.970	2.050	2.390	3.540	2.910	g
Percentage yield			121.990	98.363	120.421	108.596	118.592	114.531	140.791	73.003	75.982	98.527	122.604	105.537	%
% Na in product		43.381	17.120	22.782	16.289	18.067	31.344	24.617	17.422	37.050	35.594	18.315	15.085	15.780	%

Synthesis	No	11	12	13	14	61	15	16	17	18	19	20	21	22	
	Acid	Myristic	Palmitic	Trimesic	Mucic	Mucic	Phenylacetic	Anisic	Adipic	Uric	Coumaric	i-Cyanuric	i-Phthalic	Malonic	
	M_w	228.38	256.43	210.14	210.14	210.14	136.14	152.15	146.14	168.11	140.10	129.08	166.13	104.07	g/mol
Mass acid	*Calculated*	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	g
Mole acid		0.009	0.008	0.010	0.010	0.010	0.015	0.013	0.014	0.012	0.014	0.015	0.012	0.019	mole
Acid H		1	1	3	2	2	1	1	2	3	1	3	2	2	mole
Mass Na_2CO_3		0.928	0.827	1.009	1.009	1.009	1.557	1.393	1.451	1.261	1.513	1.642	1.276	2.037	g
Mole Na_2CO_3		0.009	0.008	0.010	0.010	0.010	0.015	0.013	0.014	0.012	0.014	0.015	0.012	0.019	mole
Mass acid	*In*	2.010	2.020	2.010	2.010	1.960	2.000	2.010	2.010	2.000	2.000	2.010	2.020	2.010	g
Mole acid		0.009	0.008	0.010	0.010	0.009	0.015	0.013	0.014	0.012	0.014	0.016	0.012	0.019	mole
Mass Na_2CO_3 (sol)		18.580	16.560	20.190	20.180	5.940	31.160	27.870	29.000	25.230	30.260	32.850	25.540	40.760	g
Mass Na_2CO_3		0.929	0.828	1.010	1.009	0.990	1.558	1.394	1.450	1.262	1.513	1.643	1.277	2.038	g
Mole Na_2CO_3		0.009	0.008	0.010	0.010	0.009	0.015	0.013	0.014	0.012	0.014	0.015	0.012	0.019	mole
Mole Na		0.018	0.016	0.019	0.019	0.019	0.029	0.026	0.027	0.024	0.029	0.031	0.024	0.038	mole
Mass Na		0.403	0.359	0.438	0.438	0.429	0.676	0.605	0.629	0.547	0.656	0.713	0.554	0.884	g
Mass expected	**Product**	2.666	2.604	2.426	2.426	2.371	3.102	2.994	2.607	2.524	3.070	2.687	2.543	2.850	g
Mass obtained	*Out*	3.100	2.950	2.890	2.400	2.594	3.500	3.180	3.400	3.220	2.820	3.350	2.900	2.690	g
Percentage yield		116.277	113.300	119.115	98.939	109.383	112.816	106.219	130.422	127.596	91.848	124.690	114.046	94.386	%
% Na in product		13.000	12.176	15.153	18.238	16.557	19.311	19.010	18.501	16.996	23.275	21.270	19.103	32.867	%

Synthesis	No	23	24	25	26	27	28	30	31	32	33	34	35	
	Acid	Stearic	Azeloic	Pyrogallic	Malic	Keto Glutaric	Picolinic	Barbitone	Glycocoll	Phthalic Anhydride	Butyl benzoic	Tiglic	Pyrazine carboxylic	
	M_w	284.48	188.22	126.11	134.09	146.10	123.11	184.20	75.07	148.12	178.23	100.12	124.10	g/mol
Mass acid	*Calculated*	2.00	2.00	2.00	2.00	2.00	2.00	2.00	1.00	2.00	2.00	2.00	2.00	g
Mole acid		0.007	0.011	0.016	0.015	0.014	0.016	0.011	0.013	0.014	0.011	0.020	0.016	mole
Acid H		1	2	3	2	2	1	2	1	2	1	1	1	mole
Mass Na_2CO_3		0.745	1.126	1.681	1.581	1.451	1.722	1.151	1.412	1.431	1.189	2.117	1.708	g
Mole Na_2CO_3		0.007	0.011	0.016	0.015	0.014	0.016	0.011	0.013	0.014	0.011	0.020	0.016	mole
Mass acid	*In*	2.020	2.000	2.020	2.000	2.000	2.010	2.000	1.010	2.000	2.010	2.010	2.000	g
Mole acid		0.007	0.011	0.016	0.015	0.014	0.016	0.011	0.013	0.014	0.011	0.020	0.016	mole
Mass Na_2CO_3 (sol)		14.920	22.530	33.620	31.650	29.040	34.440	23.020	28.250	28.640	23.810	42.480	34.170	g
Mass Na_2CO_3		0.746	1.127	1.681	1.583	1.452	1.722	1.151	1.413	1.432	1.191	2.124	1.709	g
Mole Na_2CO_3		0.007	0.011	0.016	0.015	0.014	0.016	0.011	0.013	0.014	0.011	0.020	0.016	mole
Mole Na		0.014	0.021	0.032	0.030	0.027	0.032	0.022	0.027	0.027	0.022	0.040	0.032	mole
Mass Na		0.324	0.489	0.729	0.687	0.630	0.747	0.499	0.613	0.621	0.516	0.921	0.741	g
Mass expected	**Product**	2.546	2.467	2.707	2.657	2.603	3.226	2.478	2.005	2.595	2.851	3.511	3.209	g
Mass obtained	*Out*	2.690	2.560	3.970	2.590	2.910	3.650	2.880	2.200	3.580	2.910	4.050	3.350	g
Percentage yield		105.665	103.752	146.630	97.465	111.797	113.155	116.244	109.712	137.984	102.078	115.339	104.404	%
% Na in product		12.031	19.090	18.369	26.506	21.646	20.467	17.338	27.853	17.353	17.748	22.751	22.125	%

Synthesis	No	36	37	38	39	40	41	42	43	44	45	46	48	
	Acid	Sebacic	Homophthalic	Mandelic	Maleic	Pyromellitic	Tartaric	Diamino-benzoic	Galacturonic	Glutaric	Succinic	Sorbic	Levulinic	
	M_w	202.24	180.16	152.15	116.07	254.16	150.09	152.15	212.20	132.11	118.09	112.13	116.11	g/mol
Mass acid	*Calculated*	2.00	2.00	2.00	2.00	2.25	2.00	2.00	2.00	2.00	2.00	2.00	2.00	g
Mole acid		0.010	0.011	0.013	0.017	0.009	0.013	0.013	0.009	0.015	0.017	0.018	0.017	mole
Acid H		2	2	1	2	4	2	1	1	2	2	1	1	mole
Mass Na_2CO_3		1.048	1.177	1.393	1.826	0.938	1.412	1.393	0.999	1.605	1.795	1.890	1.826	g
Mole Na_2CO_3		0.010	0.011	0.013	0.017	0.009	0.013	0.013	0.009	0.015	0.017	0.018	0.017	mole
Mass acid	*In*	2.000	2.000	2.010	2.010	2.258	2.010	2.010	2.010	2.000	2.000	2.010	2.000	g
Mole acid		0.010	0.011	0.013	0.017	0.009	0.013	0.013	0.009	0.015	0.017	0.018	0.017	mole
Mass Na_2CO_3 (sol)		20.980	23.540	27.870	36.550	18.770	28.270	27.880	19.990	32.100	35.900	37.830	36.520	g
Mass Na_2CO_3		1.049	1.177	1.394	1.828	0.939	1.414	1.394	1.000	1.605	1.795	1.892	1.826	g
Mole Na_2CO_3		0.010	0.011	0.013	0.017	0.009	0.013	0.013	0.009	0.015	0.017	0.018	0.017	mole
Mole Na		0.020	0.022	0.026	0.034	0.018	0.027	0.026	0.019	0.030	0.034	0.036	0.034	mole
Mass Na		0.455	0.511	0.605	0.793	0.407	0.613	0.605	0.434	0.696	0.779	0.821	0.792	g
Mass expected	**Product**	2.436	2.488	2.994	2.763	2.645	2.593	2.994	2.716	2.666	2.745	3.346	3.292	g
Mass obtained	*Out*	2.380	2.350	3.120	3.200	2.990	2.830	3.310	2.530	2.390	4.510	4.030	3.600	g
Percentage yield		97.716	94.436	104.215	115.799	113.040	109.146	110.543	93.160	89.647	164.327	120.457	109.362	%
% Na in product		19.121	21.728	19.376	24.775	13.617	21.668	18.270	17.138	29.133	17.266	20.361	22.004	%

Synthesis	No	49	50	51	52	53	54	55	56	57	58	59	60	
	Acid	Gluconic	Glycollic	Phytic	Nit.triacetic	Undecylenic	Hexanoic	Ethoxy acetic	Phthalic	n-Butyric	Aspartic	Benzoic	Gallic	
	M_w	196.16	76.05	660.04	191.14	182.26	116.16	104.11	166.13	88.11	133.10	122.12	188.12	g/mol
Mass acid	*Calculated*	1.50	1.32	1.60	2.00	2.00	2.00	2.00	2.00	1.00	2.00	2.00	2.00	g
Mole acid		0.008	0.017	0.002	0.010	0.011	0.017	0.019	0.012	0.011	0.015	0.016	0.011	mole
Acid H		1	1	12	3	1	1	1	2	1	2	1	1	mole
Mass Na_2CO_3		0.810	1.840	0.257	1.109	1.163	1.825	2.036	1.276	1.203	1.593	1.736	1.127	g
Mole Na_2CO_3		0.008	0.017	0.002	0.010	0.011	0.017	0.019	0.012	0.011	0.015	0.016	0.011	mole
Mass acid	*In*	1.495	1.320	1.600	2.000	2.020	2.000	2.000	2.010	0.980	2.010	2.000	2.000	g
Mole acid		0.008	0.017	0.002	0.010	0.011	0.017	0.019	0.012	0.011	0.015	0.016	0.011	mole
Mass Na_2CO_3 (sol)		16.220	36.790	5.120	22.180	23.260	36.520	40.730	25.520	24.080	31.860			g
Mass Na_2CO_3		0.811	1.840	0.256	1.109	1.163	1.826	2.037	1.276	1.204	1.593	1.736	1.130	g
Mole Na_2CO_3		0.008	0.017	0.002	0.010	0.011	0.017	0.019	0.012	0.011	0.015	0.016	0.011	mole
Mole Na		0.015	0.035	0.005	0.021	0.022	0.034	0.038	0.024	0.023	0.030	0.033	0.021	mole
Mass Na		0.352	0.798	0.111	0.481	0.505	0.792	0.883	0.554	0.522	0.691	0.753	0.490	g
Mass expected	**Product**	2.070	2.621	1.706	2.460	2.839	3.292	3.441	2.536	1.839	2.666	3.228	2.800	g
Mass obtained	*Out*	2.240	2.990		3.800	3.270	3.540	3.720	3.070	2.040		3.449	2.756	g
Percentage yield		108.231	114.069		154.472	115.170	107.532	108.116	121.078	110.926		106.843	98.418	%
% Na in product		15.706	26.689		12.661	15.429	22.377	23.749	18.031	25.604		21.835	17.787	%

No	Acid	Bubbled	Dissolved	Colour	State	Other
	Pure Na_2CO_3	-	Yes	White	Powder	-
1	**Octanoic**	Yes	Yes	White	Pieces	-
2	**n-Heptanoic**	Yes	Yes	White	Pieces	-
3	**Pelargonic**	Little	No	White	Pieces	Gelled
47	**Nonanoic**	Little	No	White	Pieces	Gelled
4	**Formic**	Yes	Yes	White	Crystals	-
5	**i-Butyric**	Yes	Yes	White	Crystals	-
6	**2-Furoic**	Yes	Yes	Yellow	Crystals	-
7	**Oxalic**	Yes	Yes	White	Crystals	-
29	**Oxalic**	Yes	Yes	White	Crystals	-
8	**Citric**	Yes	Yes	Cream	Pieces	-
9	**Decanoic**	Little	Little	White	Pieces	Add water
10	**Lauric**	No	No	White	Wax	Gelled
11	**Myristic**	Little	Little	White	Wax	Gelled, Add water
12	**Palmitic**	Little	Little	White	Wax	Add water
13	**Trimesic**	Yes	Yes	White	Crystals	-
14	**Mucic**	Yes	Yes	White	Powder	-
61	**Mucic**	Yes	Yes	White	Powder	-
15	**Phenylacetic**	Yes	Yes	White	Crystals	-
16	**Anisic**	Yes	Yes	White	Crystals	-
17	**Adipic**	Yes	Yes	White	Pieces	-
18	**Uric**	Little	Little	White	Pieces	Add water
19	**Coumaric**	Yes	Yes	Brown	Pieces	-
20	**i-Cyanuric**	Little	Little	White	Powder	-
21	**i-Phthalic**	Yes	Yes	White	Crystals	-
22	**Malonic**	Yes	Yes	White	Crystals	-
23	**Stearic**	Little	Little	White	Wax	Add water
24	**Azeloic**	Yes	Yes	White	Powder	-
25	**Pyrogallic**	No	Yes	Black	Pieces	-
26	**Malic**	Yes	Yes	Cream	Pieces	-
27	**2-Ketoglutaric**	Yes	Yes	Cream	Powder	-
28	**Picolinic**	Yes	Yes	White	Pieces	-
30	**Barbitone**	Little	Slow	White	Powder	-
31	**Glycocoll**	No	Yes	White	Pieces	-
32	**Phthalic Anhy**	Slow	Slow	Cream	Crystals	-
33	**Butyl benzoic**	Little	Slow	White	Crystals	-
34	**Tiglic**	Little	Slow	White	Crystals	-
35	**Pyr.carboxylic**	Yes	Yes	White	Crystals	-
36	**Sebacic**	Slow	Slow	White	Powder	-
37	**Homophthalic**	Yes	Yes	Cream	Powder	-
38	**Mandelic**	Yes	Yes	White	Powder	-
39	**Maleic**	Yes	Yes	White	Crystals	-
40	**Pyromellitic**	Yes	Yes	Yellow	Powder	-
41	**Tartaric**	Yes	Yes	White	Crystals	-
42	**Diam.benzoic**	Yes	Yes	Black	Crystals	-
43	**Galacturonic**	Yes	Yes	Brown	Pieces	-
44	**Glutaric**	Yes	Yes	Cream	Pieces	-
45	**Succinic**	Yes	Yes	White	Crystals	-
46	**Sorbic**	Little	Yes	Yellow	Wax	-
48	**Levulinic**	Little	No	White	Wax	Gelled
49	**Gluconic**	Yes	Yes	Brown	Pieces	-

No	Acid	Bubbled	Dissolved	Colour	State	Other
50	**Glycollic**	Yes	Yes	White	Crystals	-
51	**Phytic**	Little	Yes	-	-	-
52	**Nit.triacetic**	Yes	Yes	White	Pieces	-
53	**Undecylenic**	Little	Slow	Cream	Wax	-
54	**n-Hexanoic**	Little	Yes	Cream	Wax	-
55	**Ethoxy acetic**	Yes	Yes	White	Crystals	-
56	**Phthalic**	Yes	Yes	White	Crystals	-
57	**n-Butyric**	Yes	Yes	White	Powder	-
58	**Aspartic**	Yes	Slow	-	-	-
59	**Benzoic**	Yes	Yes	White	Crystals	-
60	**Gallic**	Yes	Yes	White	Pieces	-

Pyrolysis	No		1	2	3	47	4	5	6	7	29	8	9	10	
	Acid	Na_2CO_3	Octanoic	n-Heptanoic	Pelargonic	Nonanoic	Formic	i-Butyric	2-Furoic	Oxalic	Oxalic	Citric	Decanoic	Lauric	
Tube mass	*Before*	8.970	8.985	9.248	8.816	8.852	8.958	8.954	8.841	8.924	8.792	8.914	8.541	8.844	g
Sample mass		0.130	0.132	0.114	0.155	0.142	0.246	0.132	0.350	0.213	0.214	0.085	0.119	0.136	g
Effective mass		0.130	0.108	0.114	0.129	0.131	0.207	0.115	0.249	0.213	0.214	0.085	0.097	0.129	g
Height powder		4	5	4	6	6	7	9	10	5	5	2	5	7	mm
Mass Na in		0.056	0.019	0.026	0.021	0.024	0.065	0.028	0.043	0.079	0.076	0.016	0.015	0.020	g
Total mass	*After*	9.100	9.044	9.306	8.886	8.916	9.148	9.024	9.025	9.132	9.000	8.953	8.583	8.896	g
Height char		4	2	2	3	1	14	1	1	5	6	6	1	1	mm
Mass left (total)		0.130	0.059	0.058	0.070	0.064	0.190	0.070	0.184	0.208	0.208	0.039	0.042	0.052	g
Mass left (Na)		0.056	0.019	0.026	0.021	0.024	0.065	0.028	0.043	0.079	0.076	0.016	0.015	0.020	g
Mass left (Na_2CO_3)		0.130	0.043	0.060	0.048	0.054	0.150	0.065	0.100	0.182	0.176	0.036	0.034	0.047	g
Mass left (carbon)		0.000	0.016	-0.002	0.022	0.010	0.040	0.005	0.084	0.026	0.032	0.003	0.008	0.005	g
% carbon left		0.000	27.624	-3.221	30.956	14.912	21.117	6.571	45.742	12.541	15.584	7.987	19.638	9.858	%
Height change		0	-3	-2	-3	-5	7	-8	-9	0	1	4	-4	-6	mm

Pyrolysis	No	11	12	13	14	61	15	16	17	18	19	20	21	22	
	Acid	Myristic	Palmitic	Trimesic	Mucic	Mucic	Phenylacetic	Anisic	Adipic	Uric	Coumaric	i-Cyanuric	i-Phthalic	Malonic	
Tube mass	*Before*	8.607	8.896	8.780	8.721	11.043	8.630	8.946	8.821	9.129	9.205	9.176	8.805	9.150	g
Sample mass		0.112	0.137	0.153	0.153	0.411	0.118	0.083	0.110	0.161	0.170	0.139	0.126	0.265	g
Effective mass		0.096	0.121	0.128	0.153	0.376	0.105	0.078	0.084	0.126	0.170	0.111	0.110	0.265	g
Height powder		7	9	5	6	12	7	6	4	8	5	7	6	7	mm
Mass Na in		0.013	0.015	0.019	0.028	0.062	0.020	0.015	0.016	0.021	0.040	0.024	0.021	0.087	g
Total mass	*After*	8.645	8.938	8.870	8.803	11.247	8.682	8.988	8.893	9.212	9.326	9.285	8.915	9.359	g
Height char		1	1	8	6	14	1	2	1	10	6	9	6	4	mm
Mass left (total)		0.038	0.042	0.090	0.082	0.204	0.052	0.042	0.072	0.083	0.121	0.109	0.110	0.209	g
Mass left (Na)		0.013	0.015	0.019	0.028	0.062	0.020	0.015	0.016	0.021	0.040	0.024	0.021	0.087	g
Mass left (Na_2CO_3)		0.029	0.034	0.045	0.064	0.143	0.047	0.034	0.036	0.049	0.091	0.055	0.049	0.201	g
Mass left (carbon)		0.009	0.008	0.045	0.018	0.061	0.005	0.008	0.036	0.034	0.030	0.054	0.061	0.008	g
% carbon left		24.038	19.193	50.147	21.556	29.705	10.462	18.472	50.043	40.442	24.620	49.856	55.773	3.938	%
Height change		-6	-8	3	0	2	-6	-4	-3	2	1	2	0	-3	mm

Pyrolysis	No	23	24	25	26	27	28	30	31	32	33	34	35	
	Acid	Stearic	Azeloic	Pyrogallic	Malic	Keto Glutaric	Picolinic	Barbitone	Glycocoll	Phthalic Anhydride	Butyl benzoic	Tiglic	Pyrazine carboxylic	
Tube mass	*Before*	9.099	9.007	8.920	9.023	8.445	9.096	9.176	9.298	8.853	8.731	8.904	9.023	g
Sample mass		0.124	0.156	0.141	0.152	0.138	0.203	0.217	0.166	0.205	0.126	0.172	0.143	g
Effective mass		0.117	0.150	0.096	0.152	0.123	0.179	0.187	0.151	0.149	0.123	0.149	0.137	g
Height powder		9	7	5	5	5	8	7	6	9	15	8	7	mm
Mass Na in		0.014	0.029	0.018	0.040	0.027	0.037	0.032	0.042	0.026	0.022	0.034	0.030	g
Total mass	*After*	9.141	9.100	9.020	9.127	8.531	9.220	9.266	9.415	9.007	8.844	8.997	9.116	g
Height char		1	1	8	16	7	1	7	8	32	1	1	38	mm
Mass left (total)		0.042	0.093	0.100	0.104	0.086	0.124	0.090	0.117	0.154	0.113	0.093	0.093	g
Mass left (Na)		0.014	0.029	0.018	0.040	0.027	0.037	0.032	0.042	0.026	0.022	0.034	0.030	g
Mass left (Na_2CO_3)		0.033	0.066	0.041	0.093	0.062	0.085	0.075	0.097	0.059	0.050	0.078	0.070	g
Mass left (carbon)		0.009	0.027	0.059	0.011	0.024	0.039	0.015	0.020	0.095	0.063	0.015	0.023	g
% carbon left		22.513	28.856	59.283	10.699	28.382	31.744	17.105	16.970	61.411	55.312	15.905	24.888	%
Height change		-8	-6	3	11	2	-7	0	2	23	-14	-7	31	mm

Pyrolysis	No	36	37	38	39	40	41	42	43	44	45	46	48	
	Acid	Sebatic	Homophthalic	Mandelic	Maleic	Pyromellitic	Tartaric	Diamino benzoic	Galacturonic	Glutaric	Succinic	Sorbic	Levulinic	
Tube mass	*Before*	9.280	9.111	8.895	9.191	9.146	9.054	9.162	9.055	9.008	8.950	8.914	8.677	g
Sample mass		0.191	0.154	0.188	0.174	0.185	0.234	0.143	0.222	0.188	0.267	0.235	0.203	g
Effective mass		0.191	0.154	0.180	0.150	0.164	0.214	0.129	0.222	0.188	0.162	0.195	0.186	g
Height powder		7	5	9	8	8	5	6	7	6	9	10	9	mm
Mass Na in		0.037	0.033	0.035	0.037	0.022	0.046	0.024	0.038	0.055	0.028	0.040	0.041	g
Total mass	*After*	9.389	9.242	8.982	9.308	9.252	9.175	9.258	9.163	9.139	9.061	9.038	8.793	g
Height char		1	1	7	20	9	9	10	2	1	9	10	2	mm
Mass left (total)		0.109	0.131	0.087	0.117	0.106	0.121	0.096	0.108	0.131	0.111	0.124	0.116	g
Mass left (Na)		0.037	0.033	0.035	0.037	0.022	0.046	0.024	0.038	0.055	0.028	0.040	0.041	g
Mass left (Na_2CO_3)		0.084	0.077	0.081	0.086	0.051	0.107	0.054	0.088	0.126	0.065	0.092	0.094	g
Mass left (carbon)		0.025	0.054	0.006	0.031	0.055	0.014	0.042	0.020	0.005	0.046	0.032	0.022	g
% carbon left		22.767	41.121	7.390	26.656	51.539	11.502	43.250	18.793	3.625	41.740	26.156	18.835	%
Height change		-6	-4	-2	12	1	4	4	-5	-5	0	0	-7	mm

Pyrolysis	No	49	50	51	52	53	54	55	56	57	58	59	60	
	Acid	Gluconic	Glycollic	Phytic	Nit.triacetic	Undecylenic	n-Hexanoic	Ethoxy acetic	Phthalic	n-Butyric	Aspartic	Benzoic	Gallic	
Tube mass	*Before*	9.193	9.083		9.300	9.050	8.767	9.018	8.585	9.181		10.324	10.436	g
Sample mass		0.125	0.224		0.230	0.197	0.191	0.188	0.150	0.131		0.206	0.221	g
Effective mass		0.115	0.196		0.149	0.171	0.178	0.174	0.124	0.118		0.193	0.221	g
Height powder		6	8		7	7	10	8	5	7		7	6	mm
Mass Na in		0.018	0.052		0.019	0.026	0.040	0.041	0.022	0.030		0.042	0.039	g
Total mass	*After*	9.257	9.220		9.444	9.136	8.870	9.119	8.711	9.265		10.478	10.567	g
Height char		6	9		10	1	41	28	27	2		0	52	mm
Mass left (total)		0.064	0.137		0.144	0.086	0.103	0.101	0.126	0.084		0.154	0.131	g
Mass left (Na)		0.018	0.052		0.019	0.026	0.040	0.041	0.022	0.030		0.042	0.039	g
Mass left (Na_2CO_3)		0.042	0.121		0.043	0.061	0.092	0.095	0.051	0.070		0.097	0.091	g
Mass left (carbon)		0.022	0.016		0.101	0.025	0.011	0.006	0.075	0.014		0.057	0.040	g
% carbon left		34.664	11.816		69.824	29.261	11.048	5.749	59.133	17.023		36.983	30.830	%
Height change		0	1		3	-6	31	20	22	-5		-7	46	mm

7.13. Appendix M

7.13.1. Summarised results for the gluconate synthesis.

Tabulated results of the standardisation of the synthesised gluconates

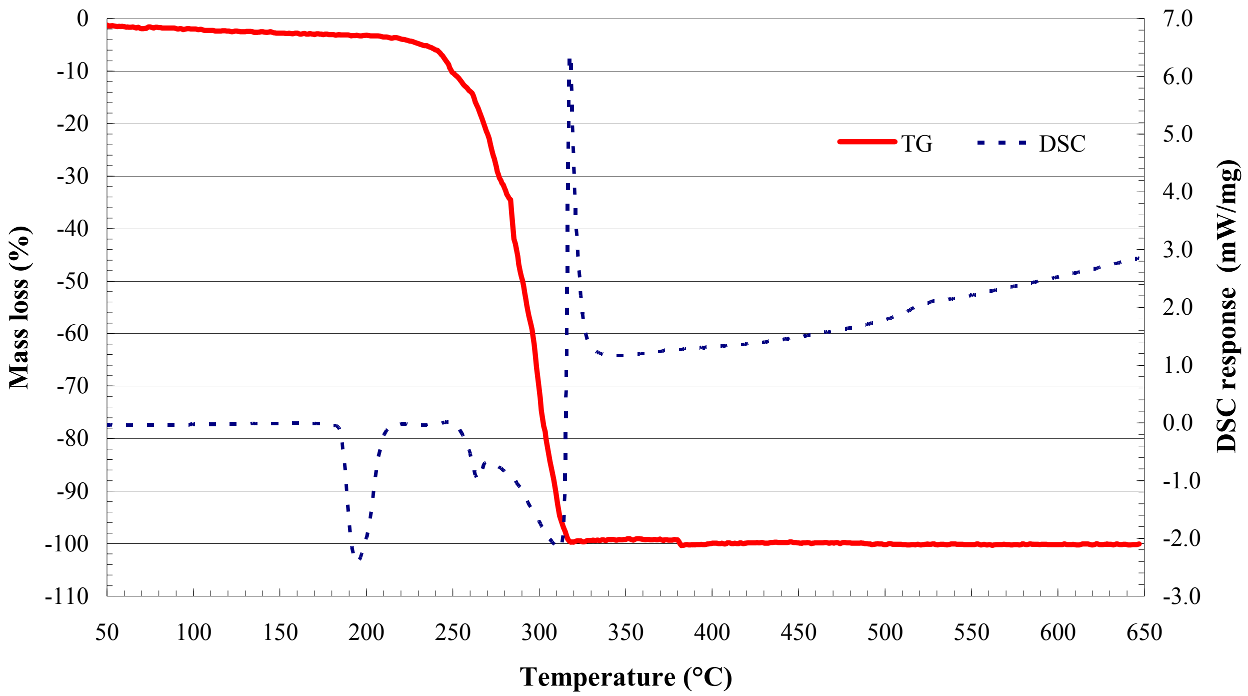
Metal	Theoretical ratio metal to gluconate	Calculated% metal in gluconate	Calculated ratio metal to gluconate (inc. water)
Al	1:3	9.10	1:1.38
Na	1:1	8.52	1:1.27
Sb	1:3	22.13	1:2.20
Zn	1:2	13.06	1:2.22
Zr	1:2#	29.97	1:1.09
Ca*	1:2	6.57	1:2.92
Cu*	1:2	13.42	1:2.10
Fe*	1:2	9.44	1:2.74
Mg*	1:2	4.13	1:2.22

* commercial material

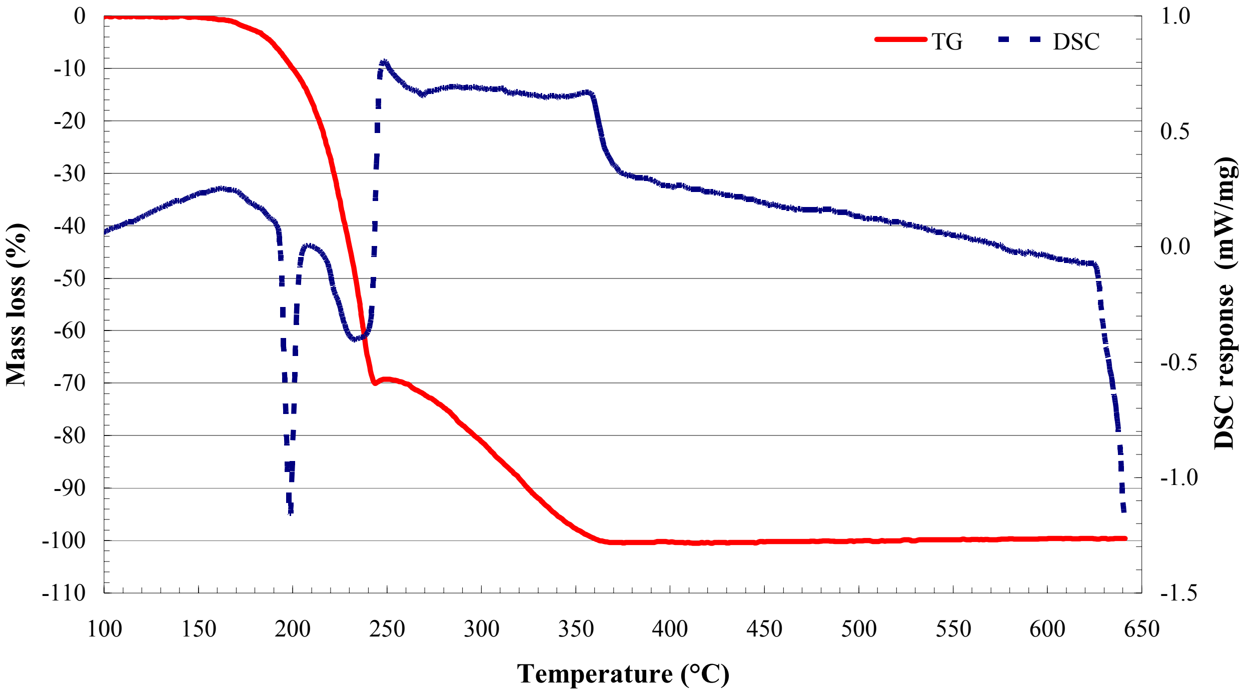
basic Zr salt (ZrO^{2-})

7.13.2. Thermal analysis of pentaerythritol, the acetylacetonates and acetylacetonate/pentaerythritol mixtures.

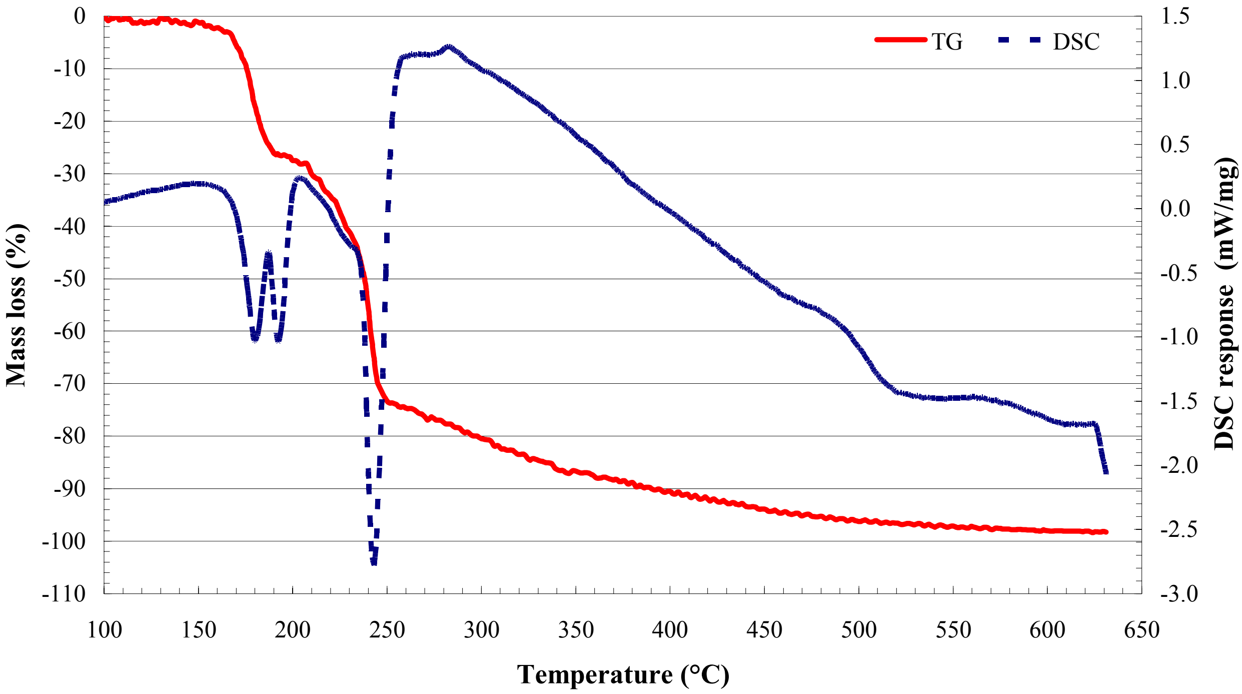
All DCS/TGA scans were done at a scan rate of 10°C from room temperature to 1000°C in air, unless indicated otherwise.



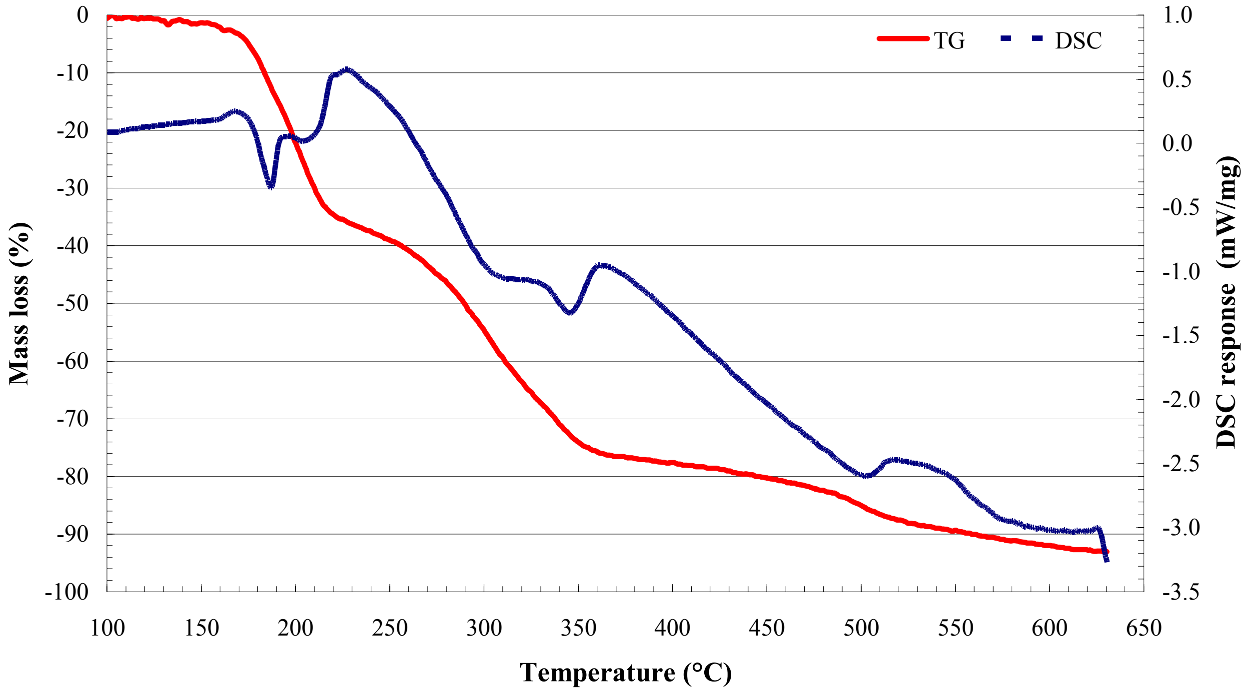
DSC/TGA scan of Pentaerythritol



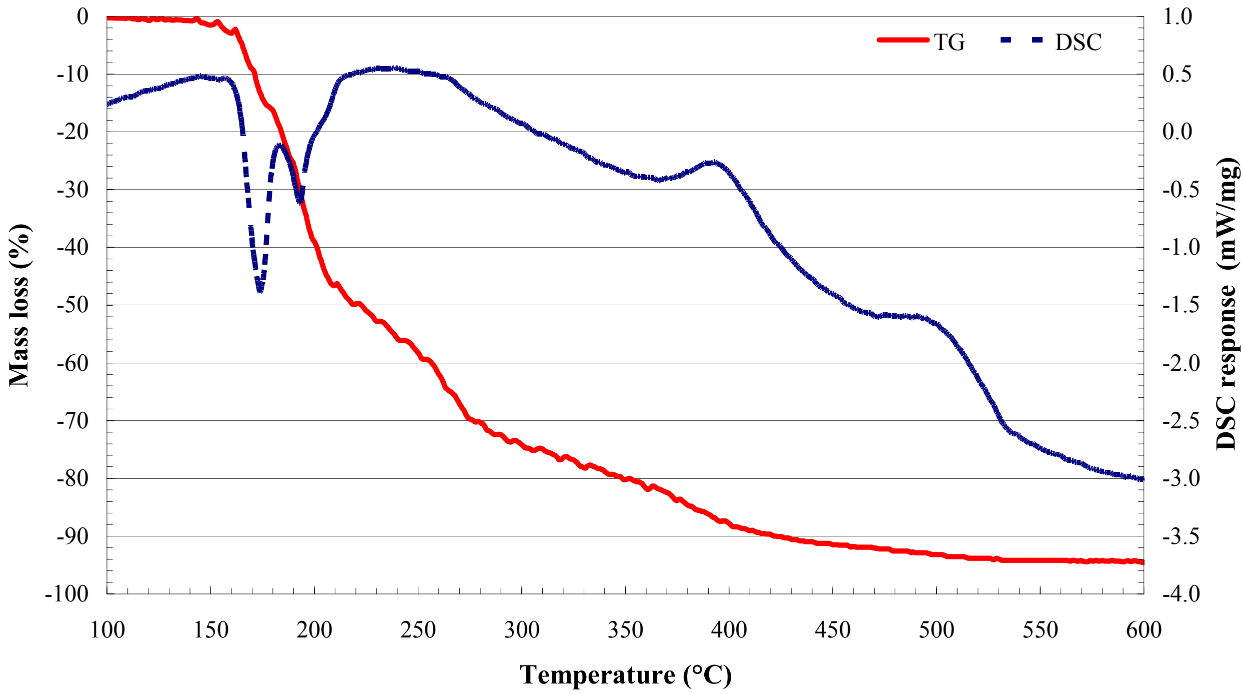
DSC/TGA scan of Al acetylacetonate



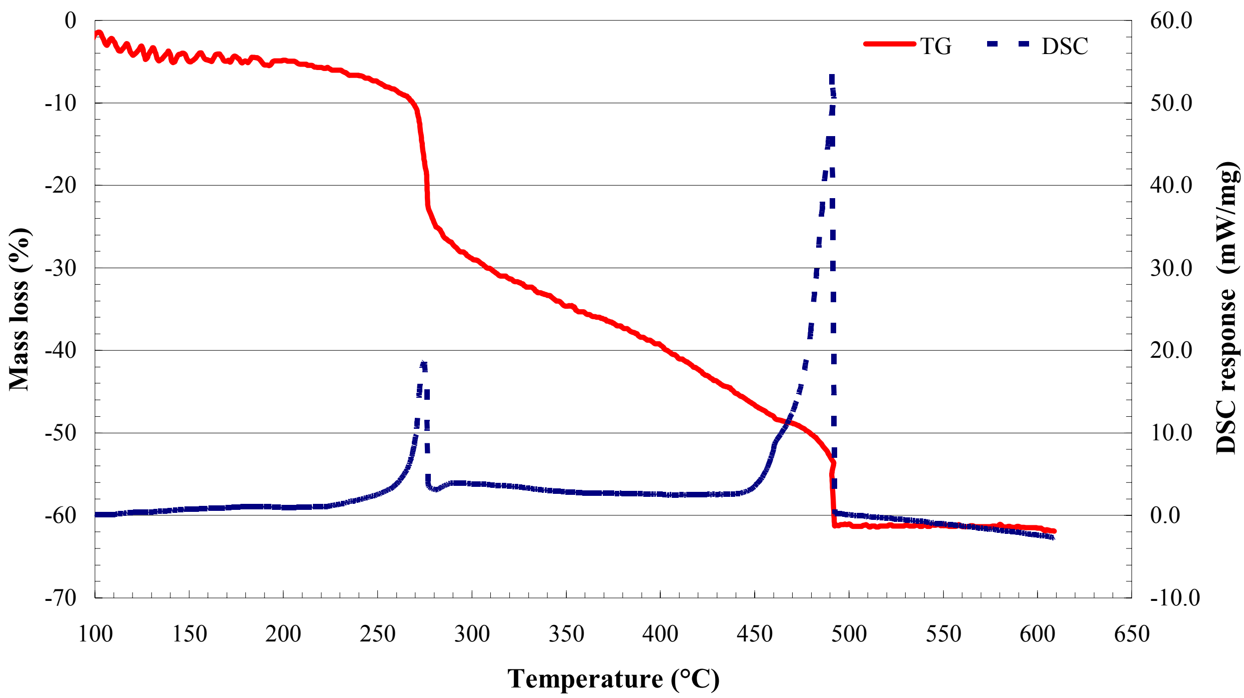
DSC/TGA scan of Al acetylacetonate/pentaerythritol mixture



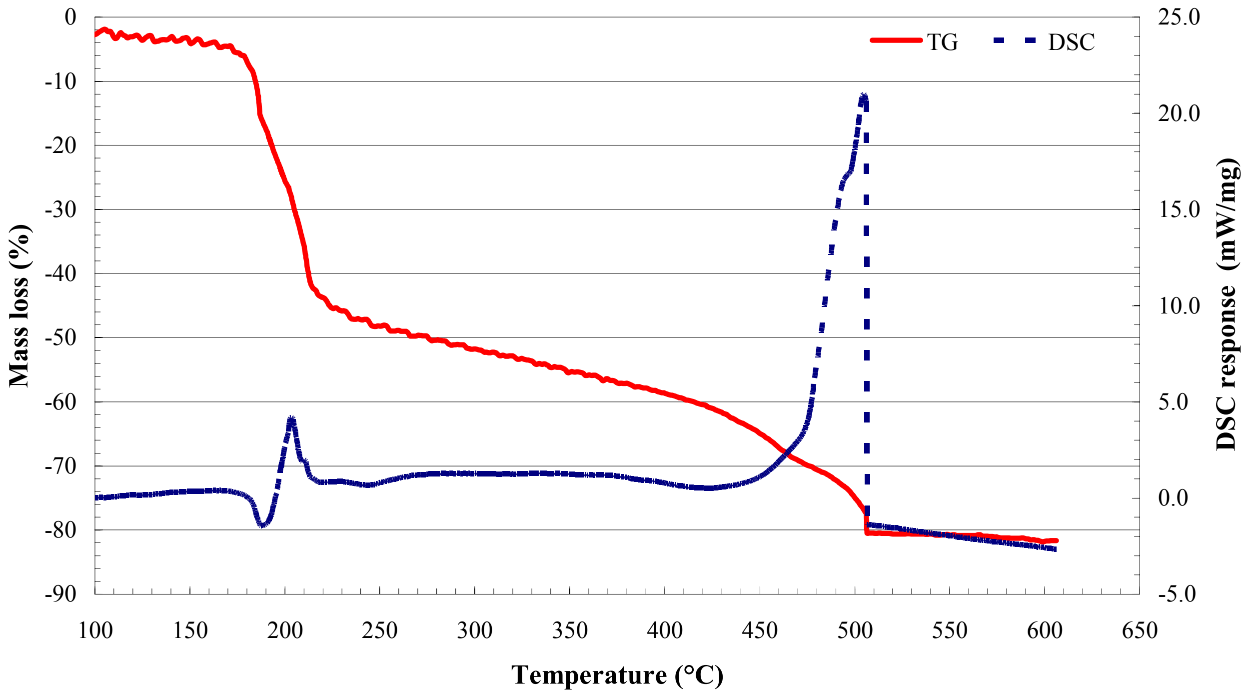
DSC/TGA scan of Al acetylacetonate/fumaric acid mixture



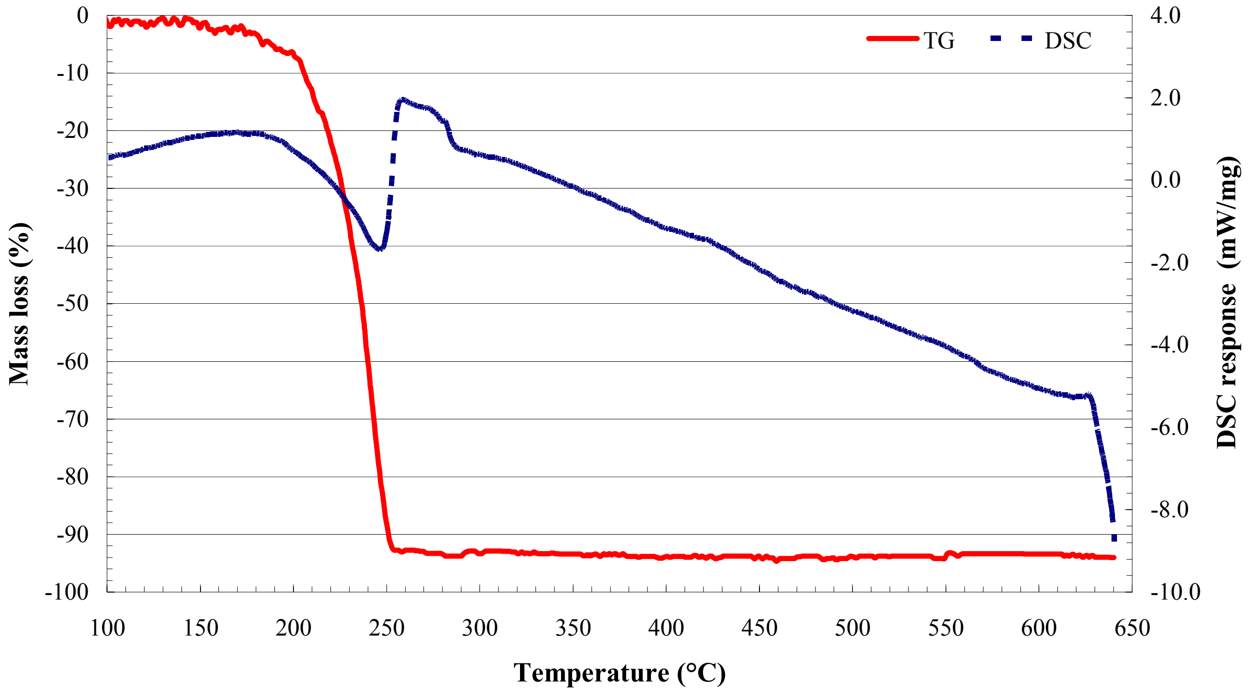
DSC/TGA scan of Al acetylacetonate/tartaric acid mixture



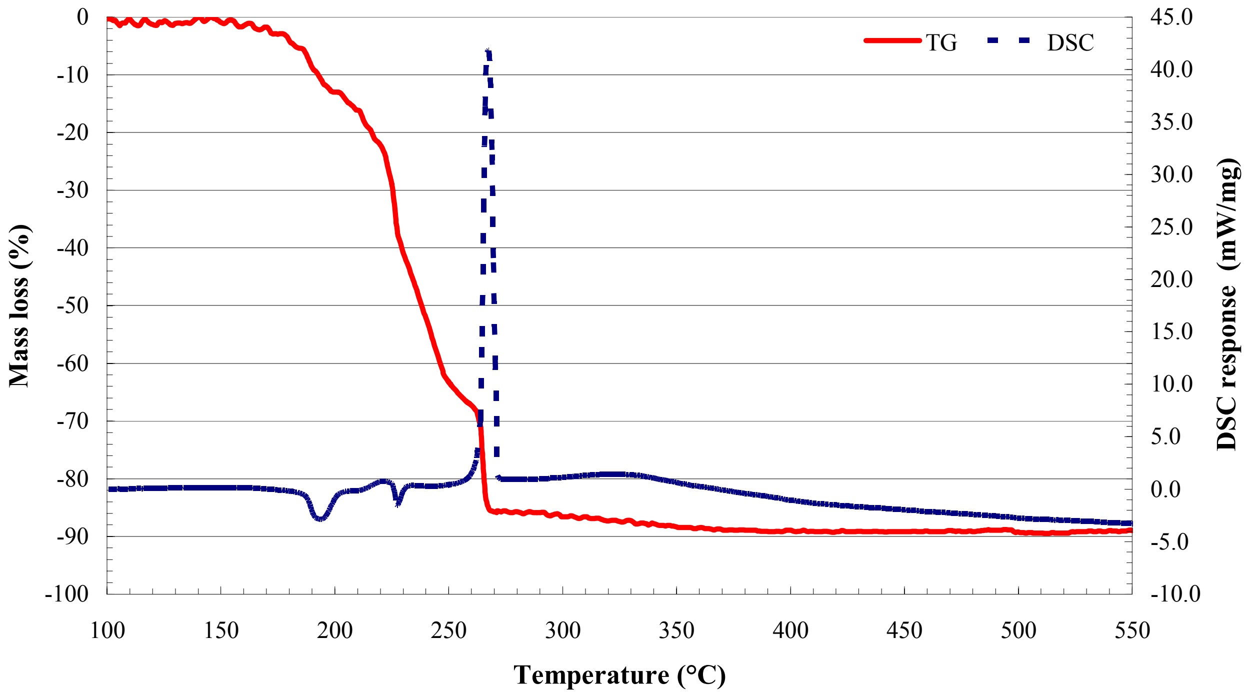
DSC/TGA scan of Ca acetylacetonate



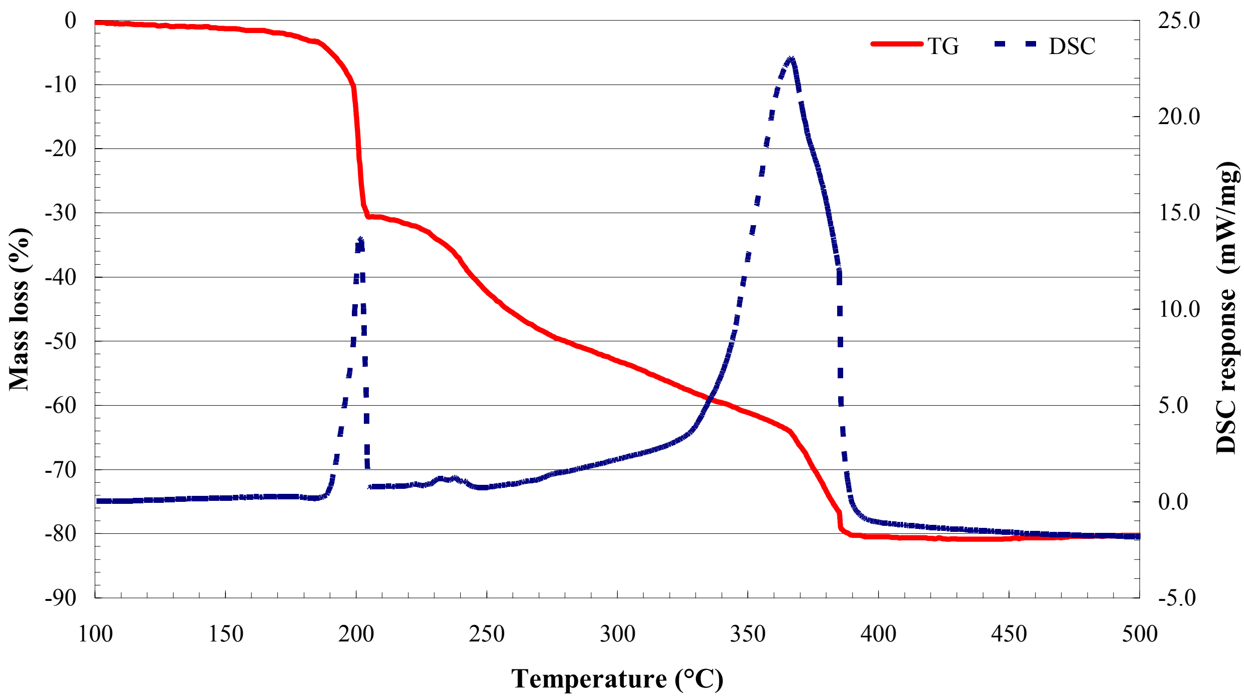
DSC/TGA scan of Ca acetylacetonate/pentaerythritol mixture



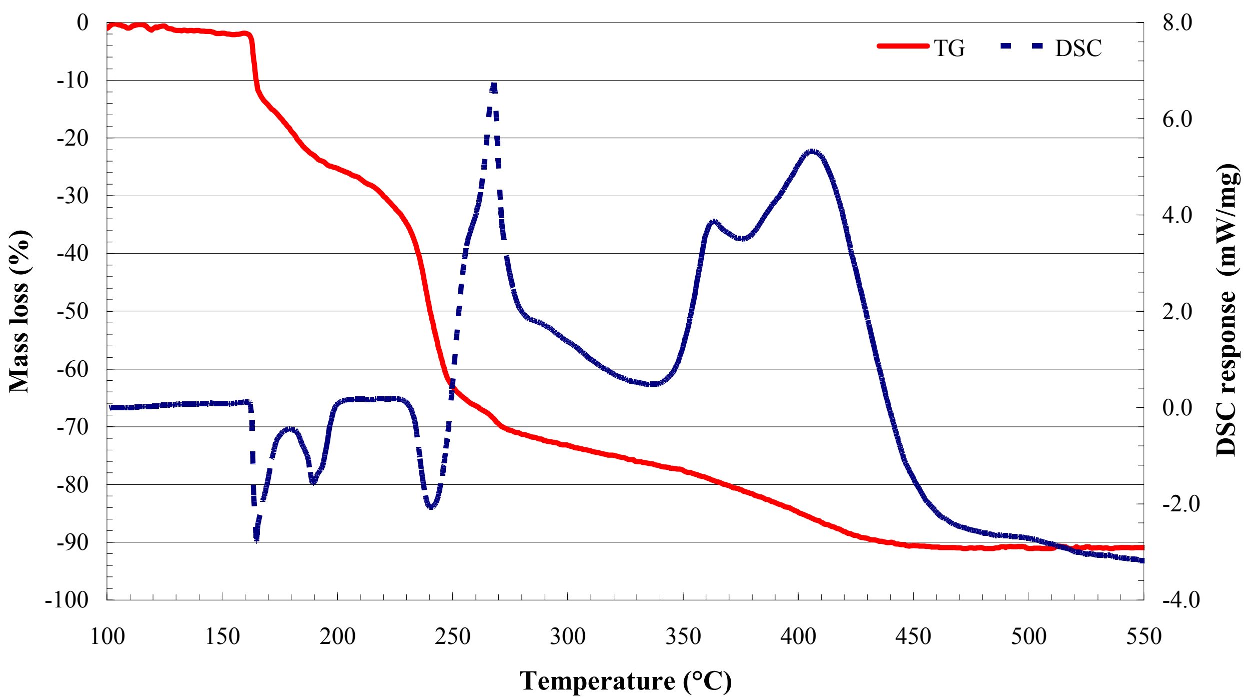
DSC/TGA scan of Cu acetylacetonate



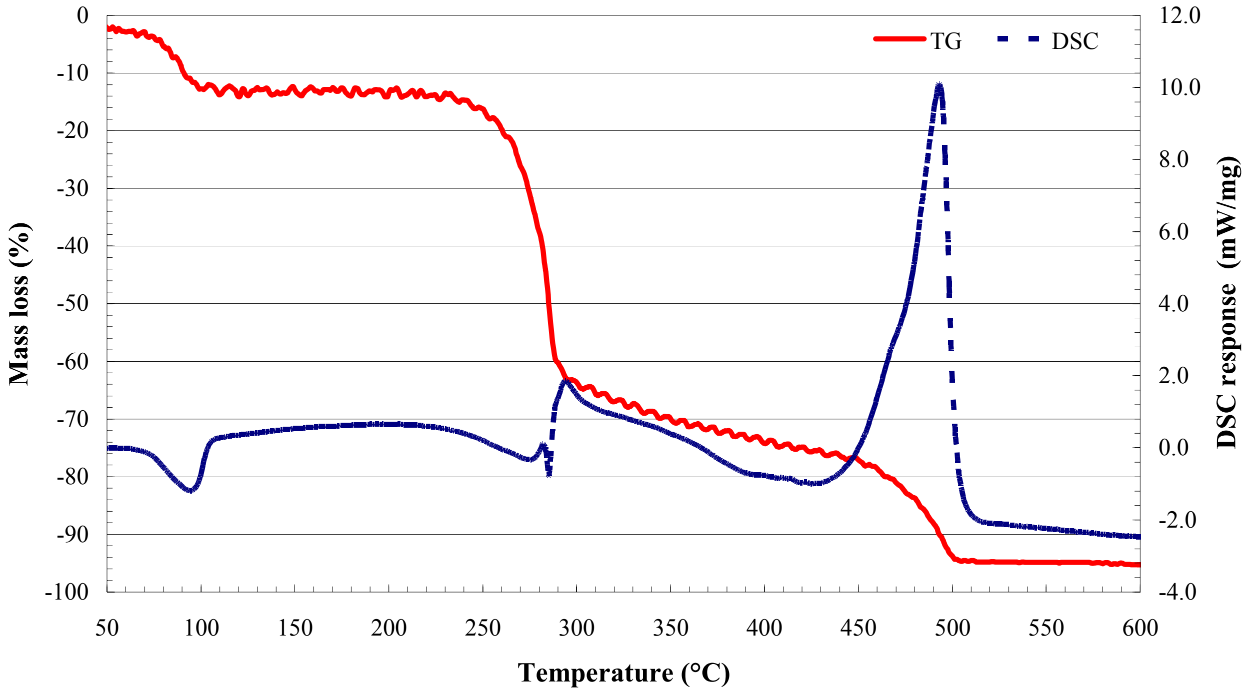
DSC/TGA scan of Cu acetylacetonate/pentaerythritol mixture



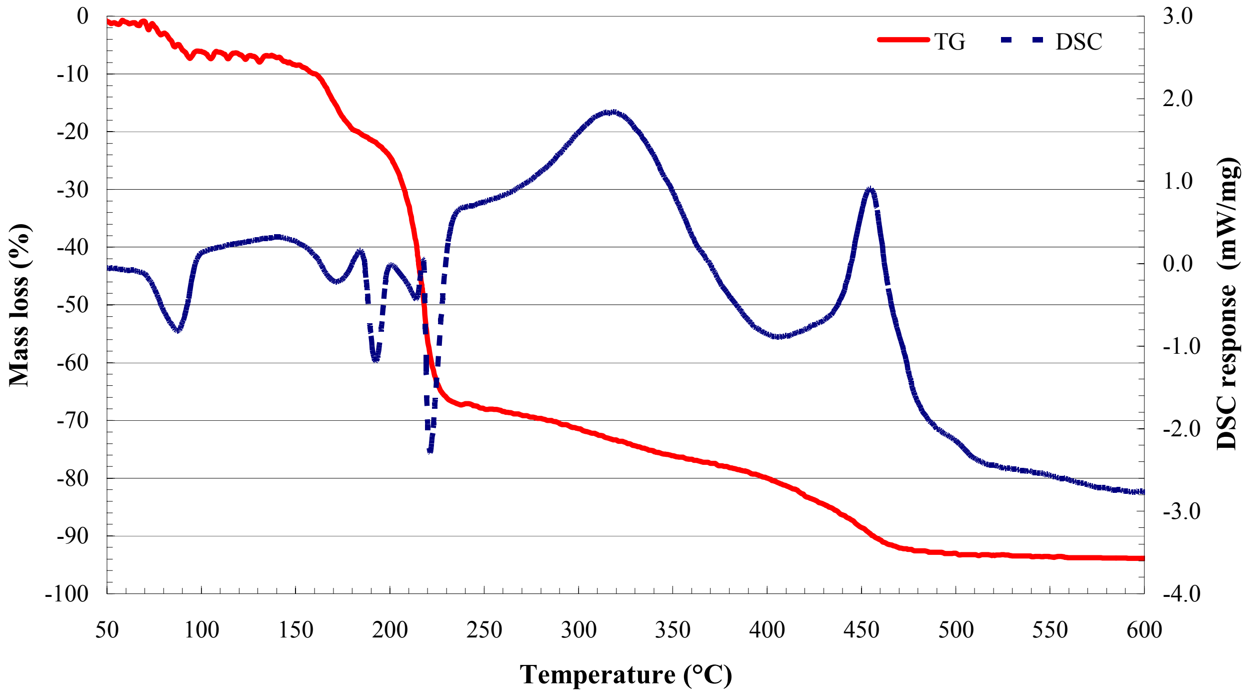
DSC/TGA scan of Fe acetylacetonate



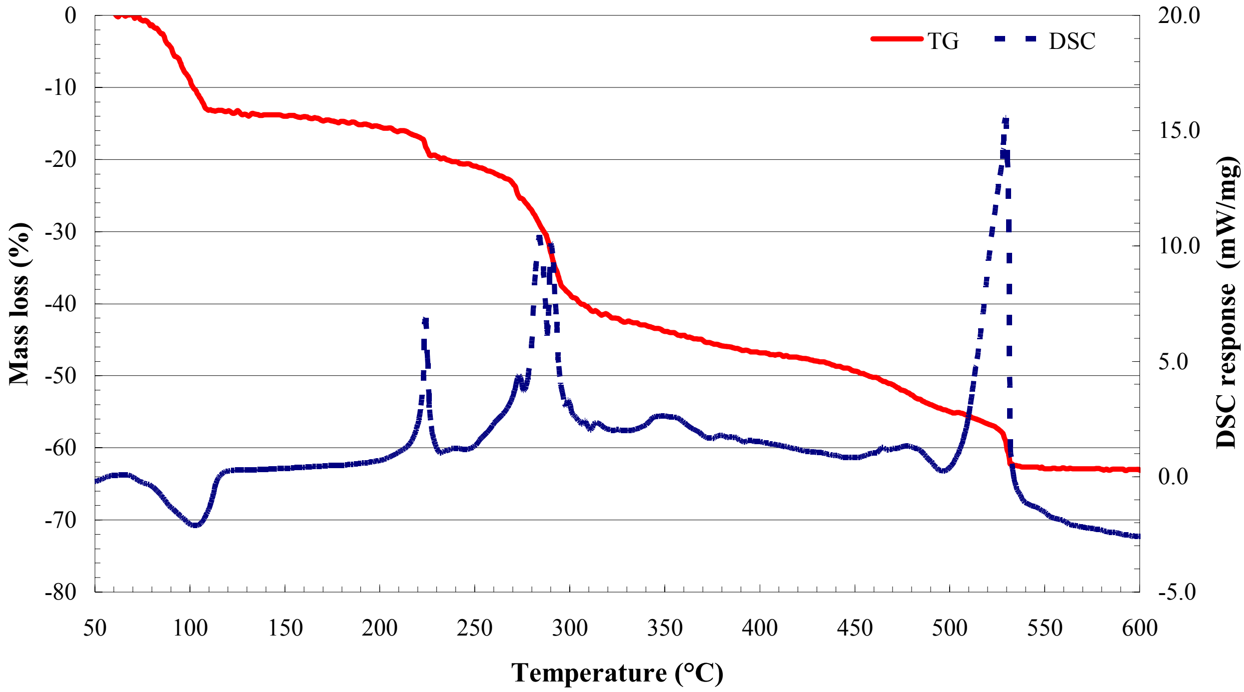
DSC/TGA scan of Fe acetylacetonate/pentaerythritol mixture



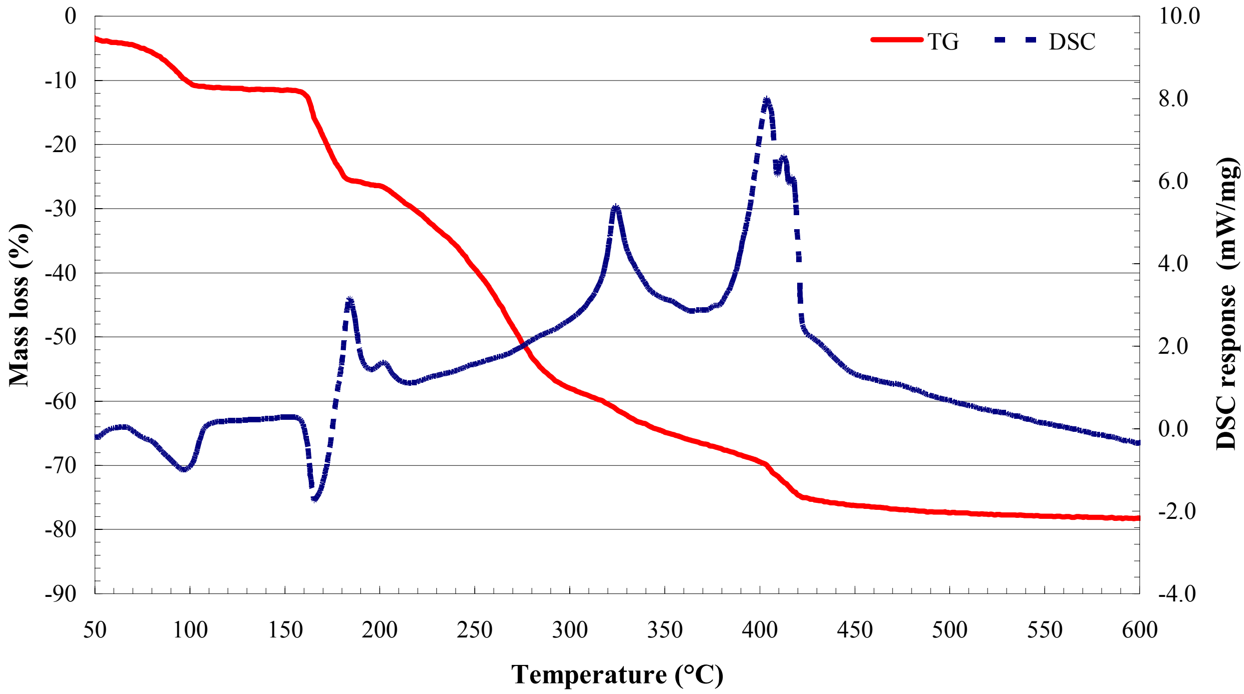
DSC/TGA scan of Mg acetylacetonate



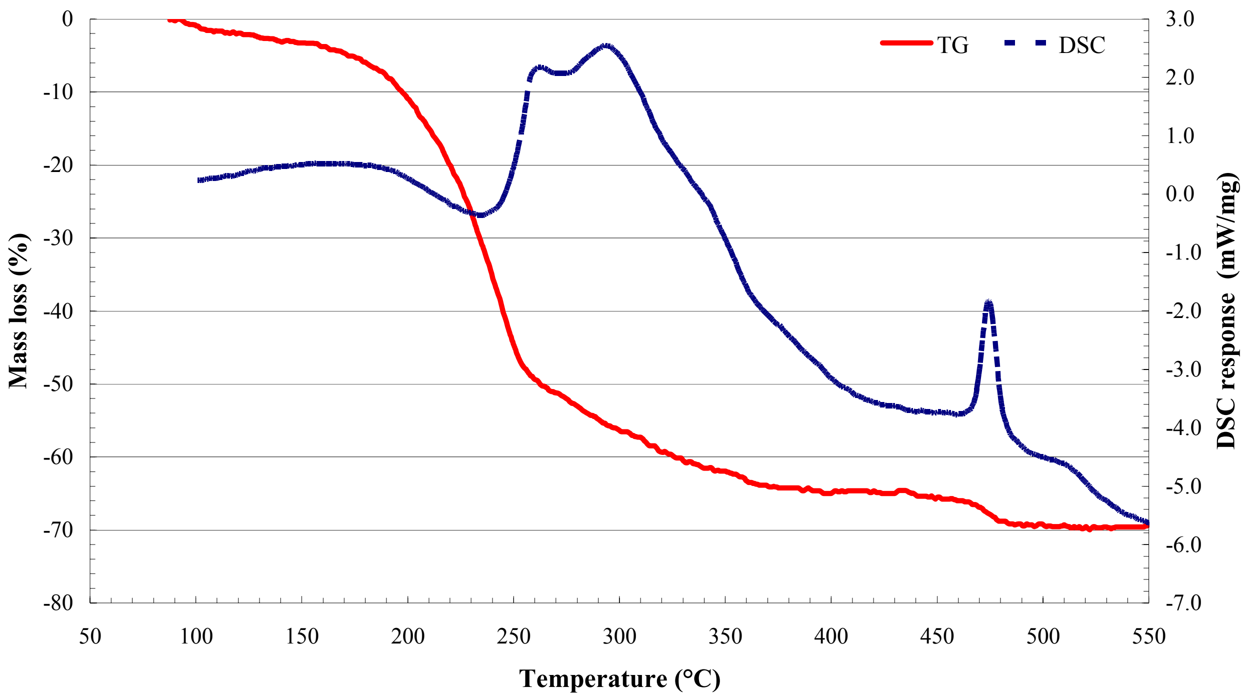
DSC/TGA scan of Mg acetylacetonate/pentaerythritol mixture



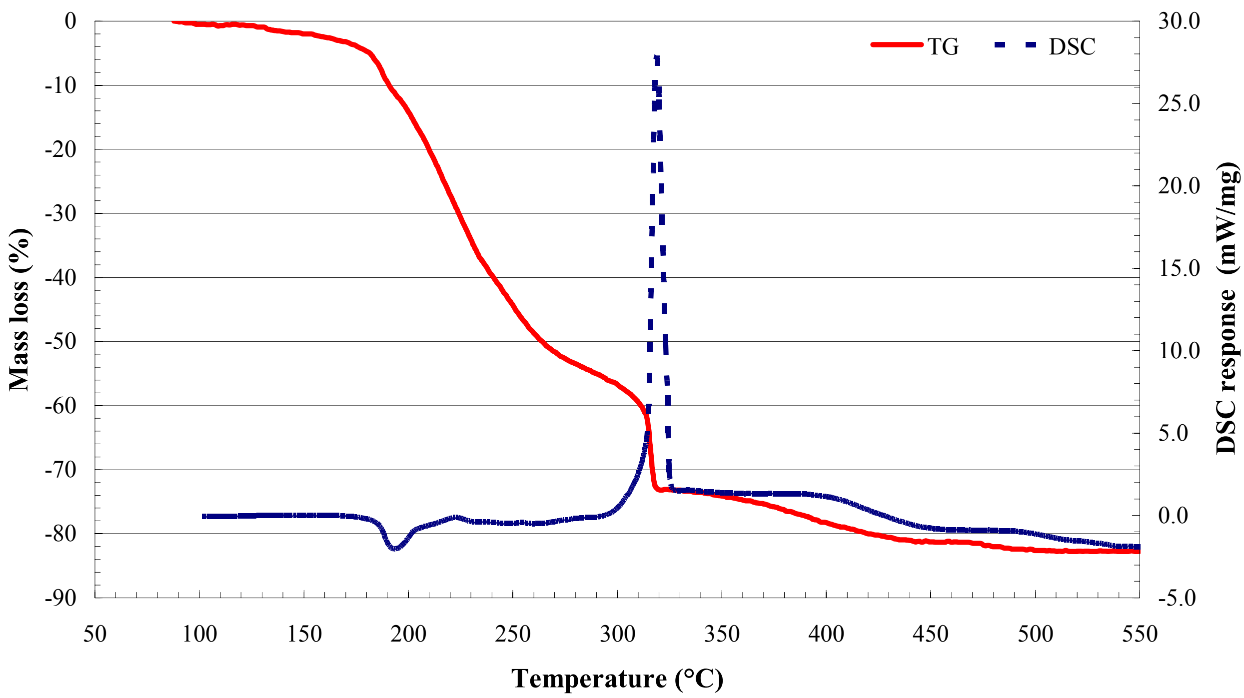
DSC/TGA scan of Na acetylacetonate



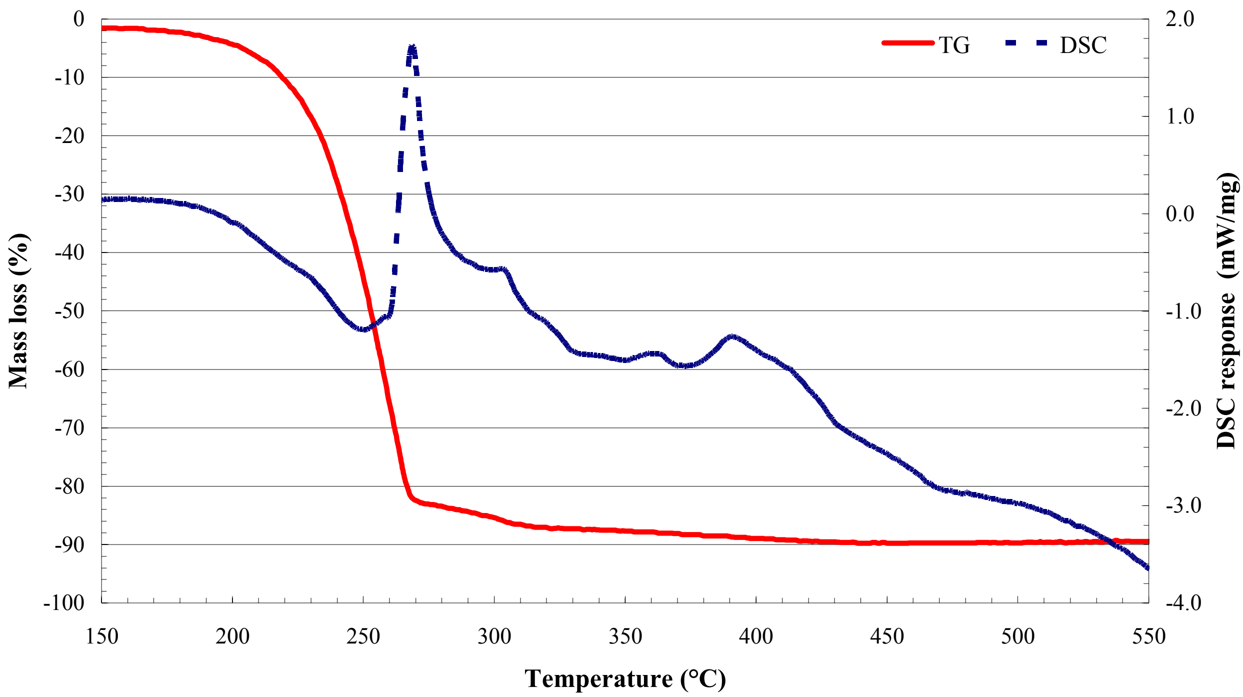
DSC/TGA scan of Na acetylacetonate/pentaerythritol mixture



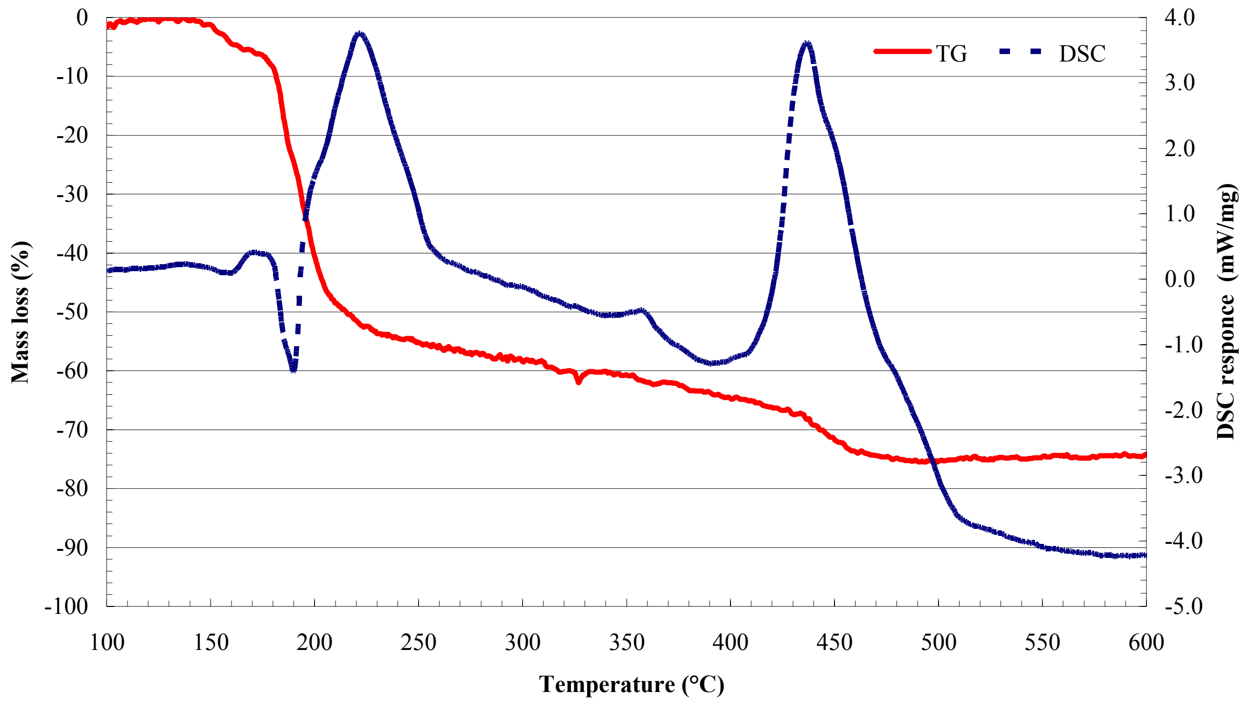
DSC/TGA scan of Ti acetylacetonate



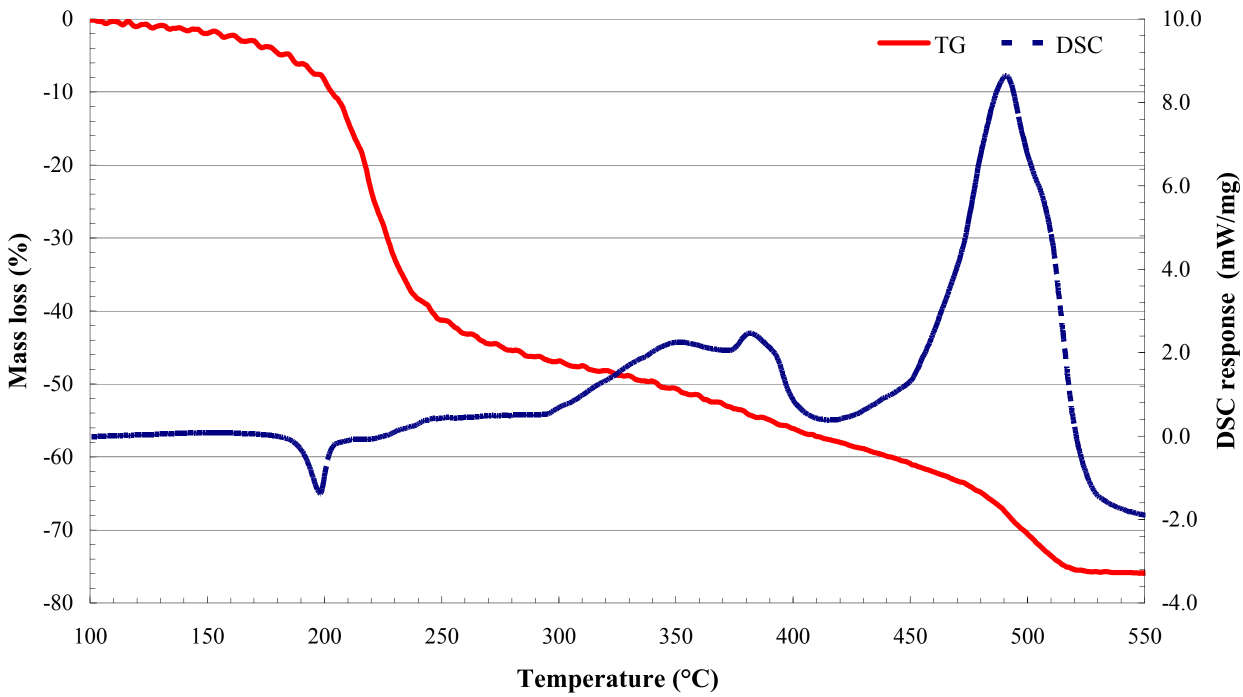
DSC/TGA scan of Ti acetylacetonate/pentaerythritol mixture



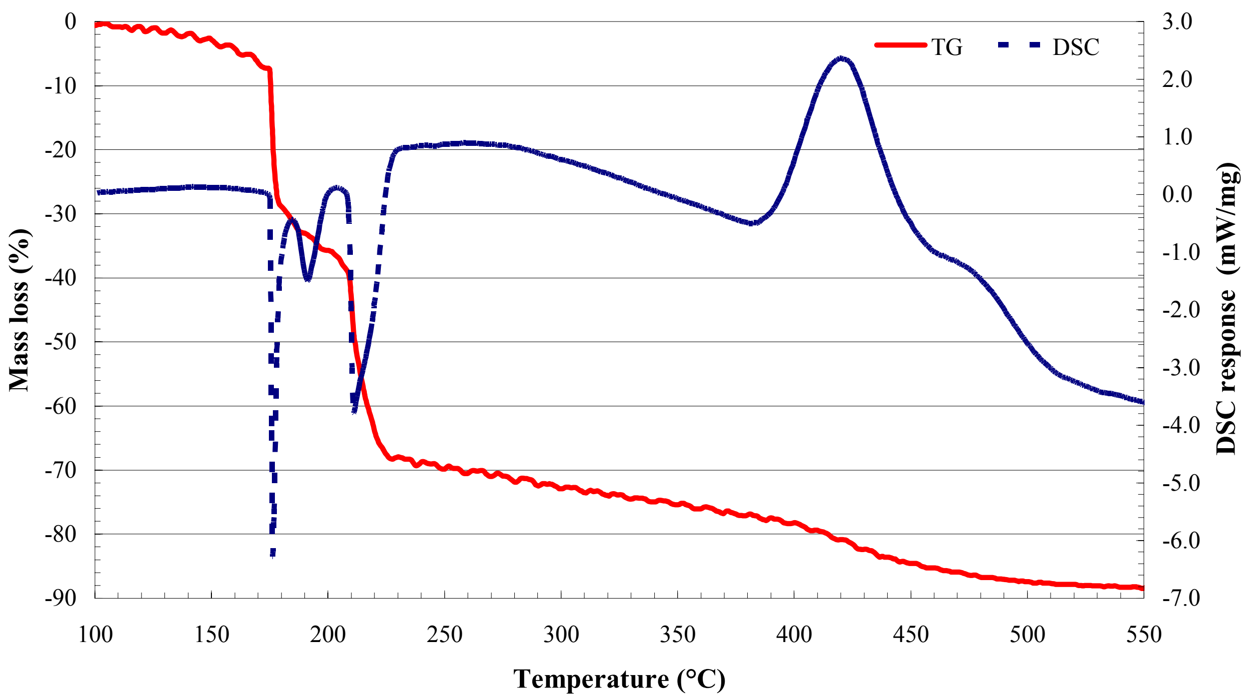
DSC/TGA scan of V acetylacetonate



DSC/TGA of V acetylacetonate/pentaerythritol mixture

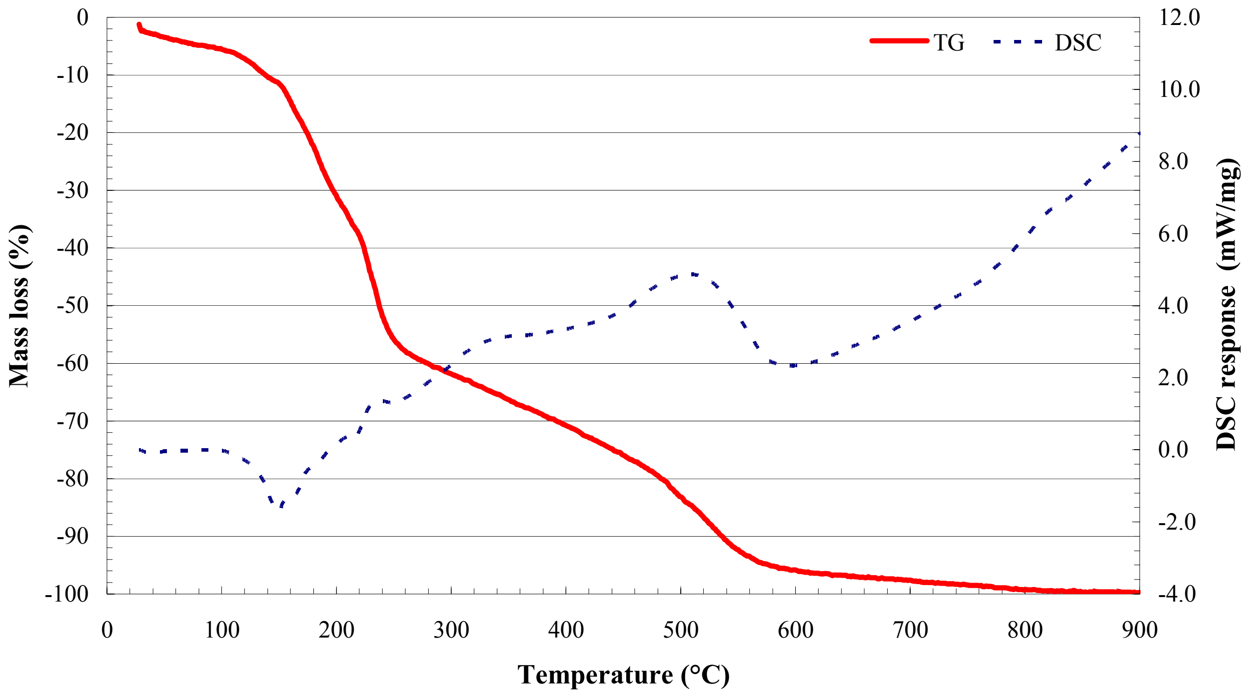


DSC/TGA scan of Zr acetylacetonate

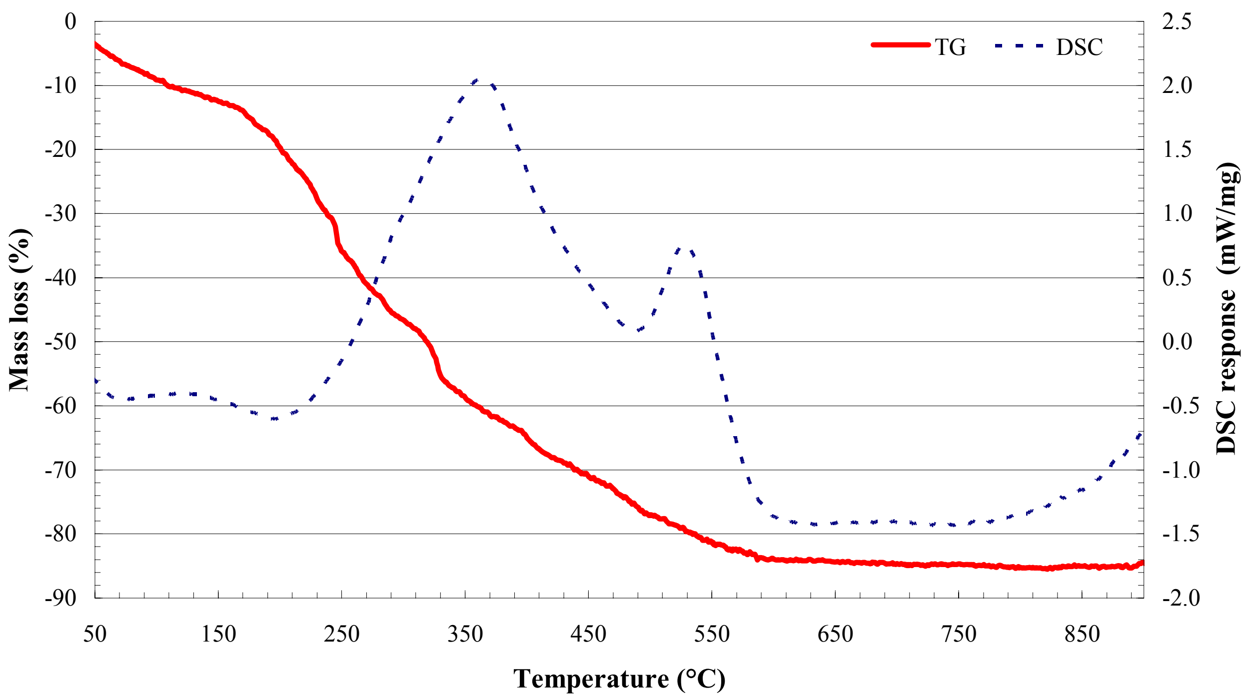


DSC/TGA scan of Zr acetylacetonate/pentaerythritol mixture

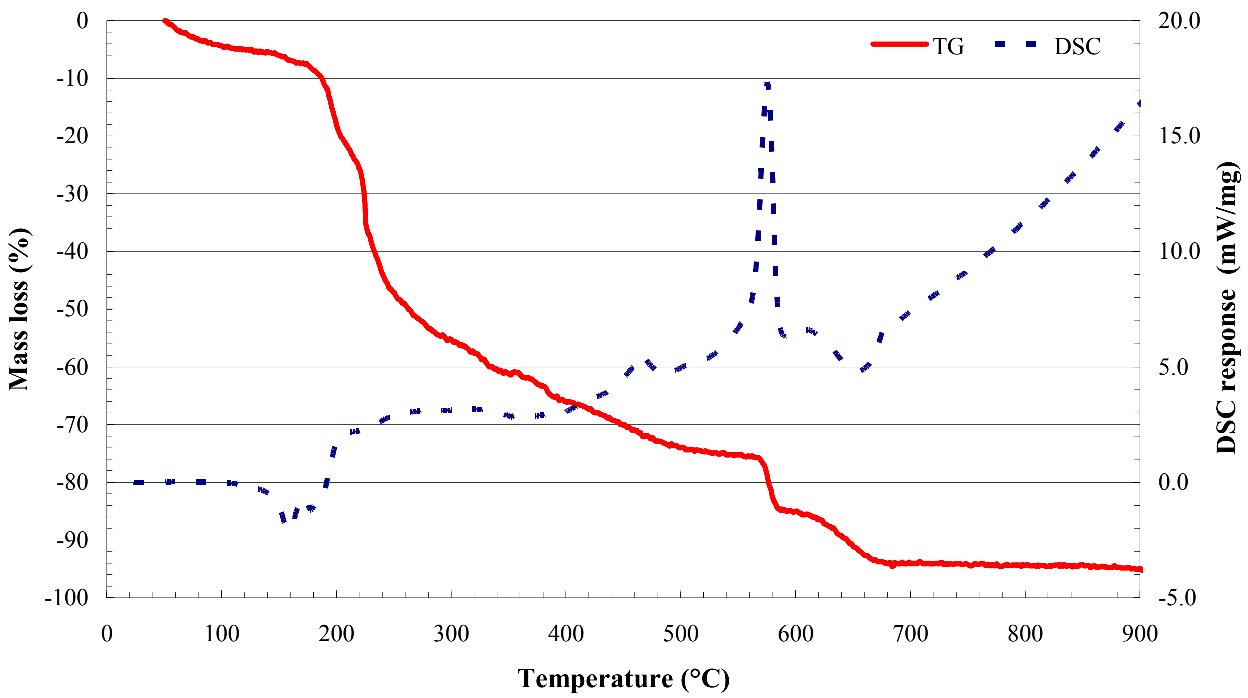
7.13.3. Thermal analysis of the gluconates.



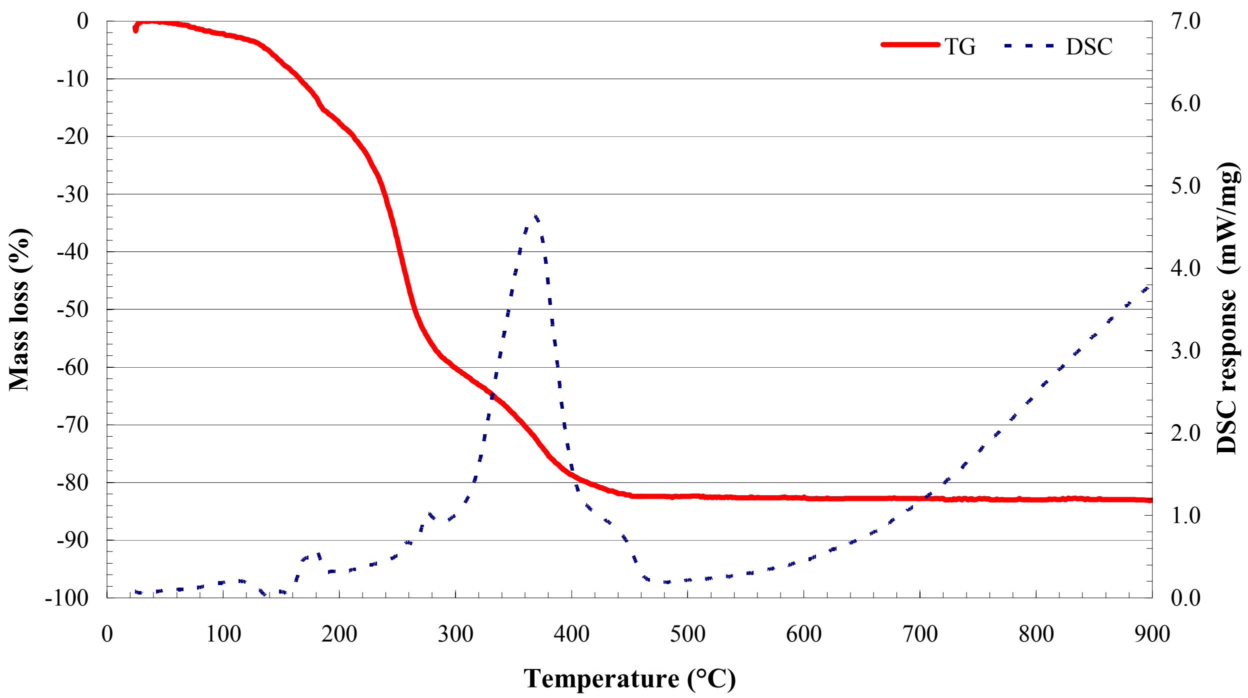
DSC/TGA scan of NH_4 gluconate



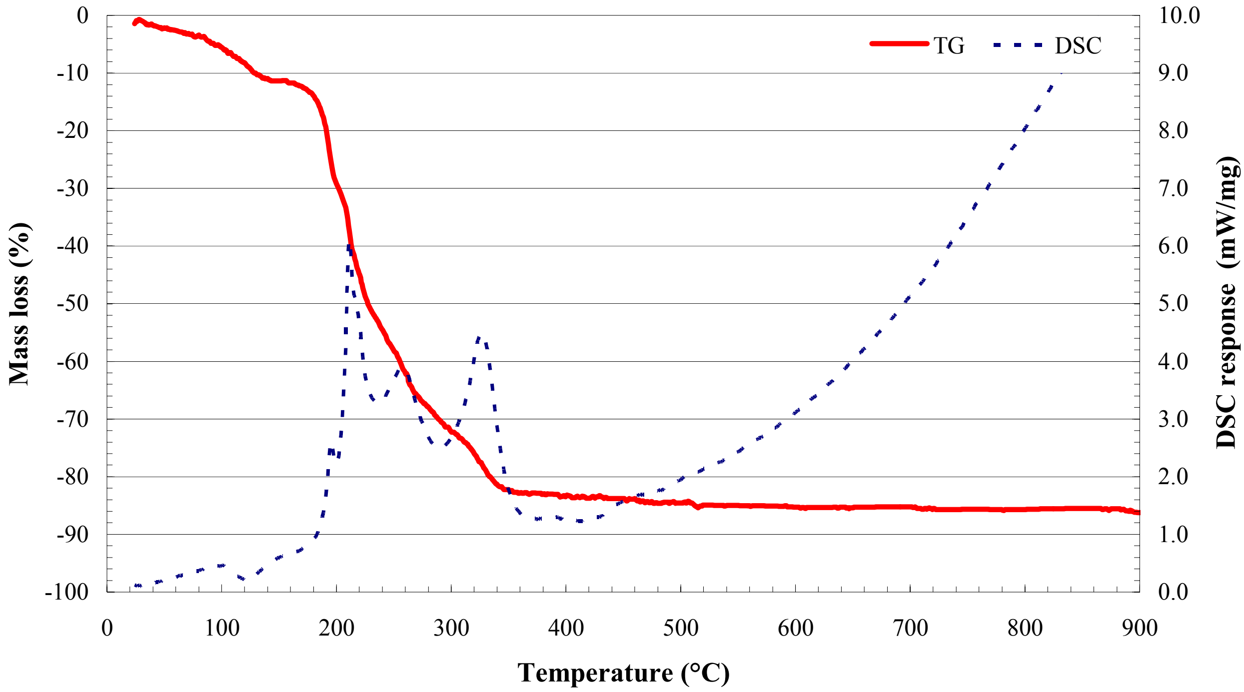
DSC/TGA scan of Al gluconate



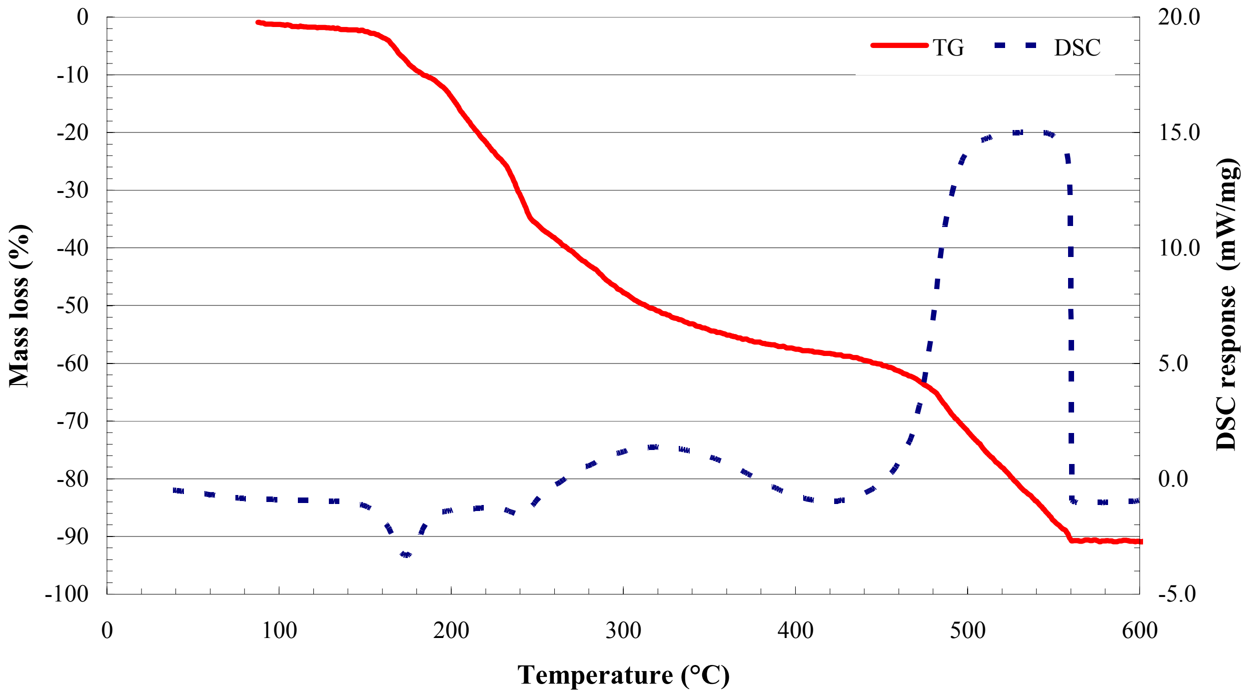
DSC/TGA scan of Ca gluconate



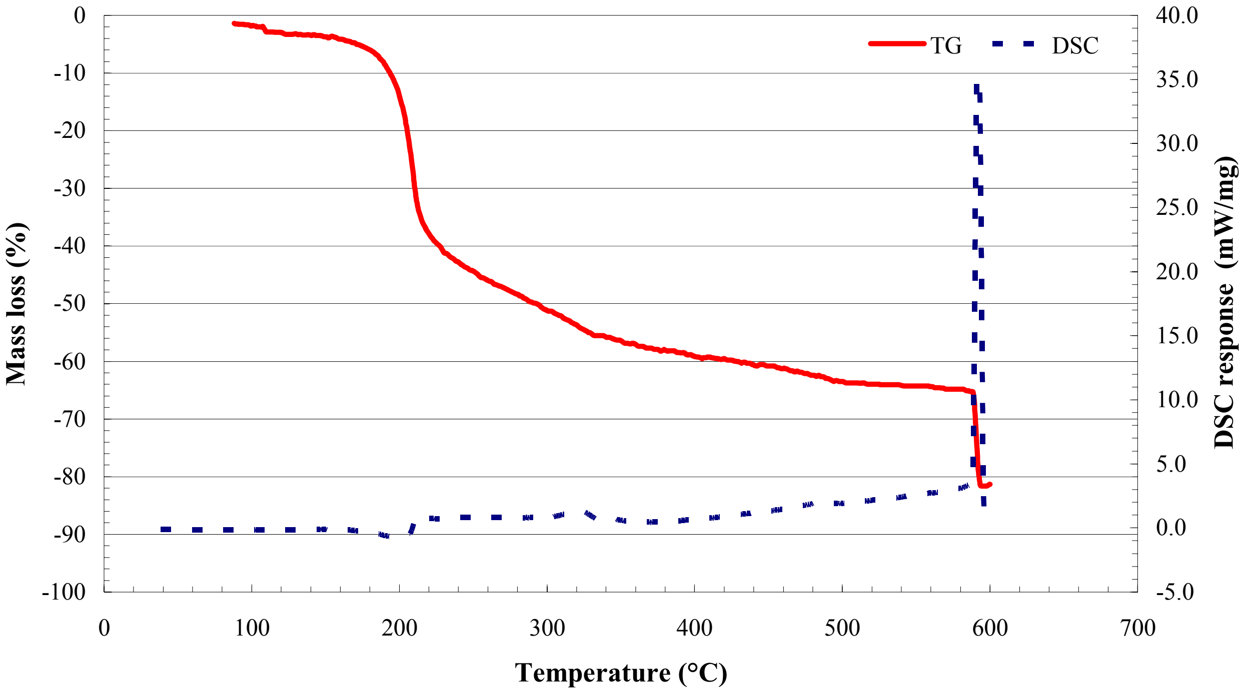
DSC/TGA scan of Cu gluconate



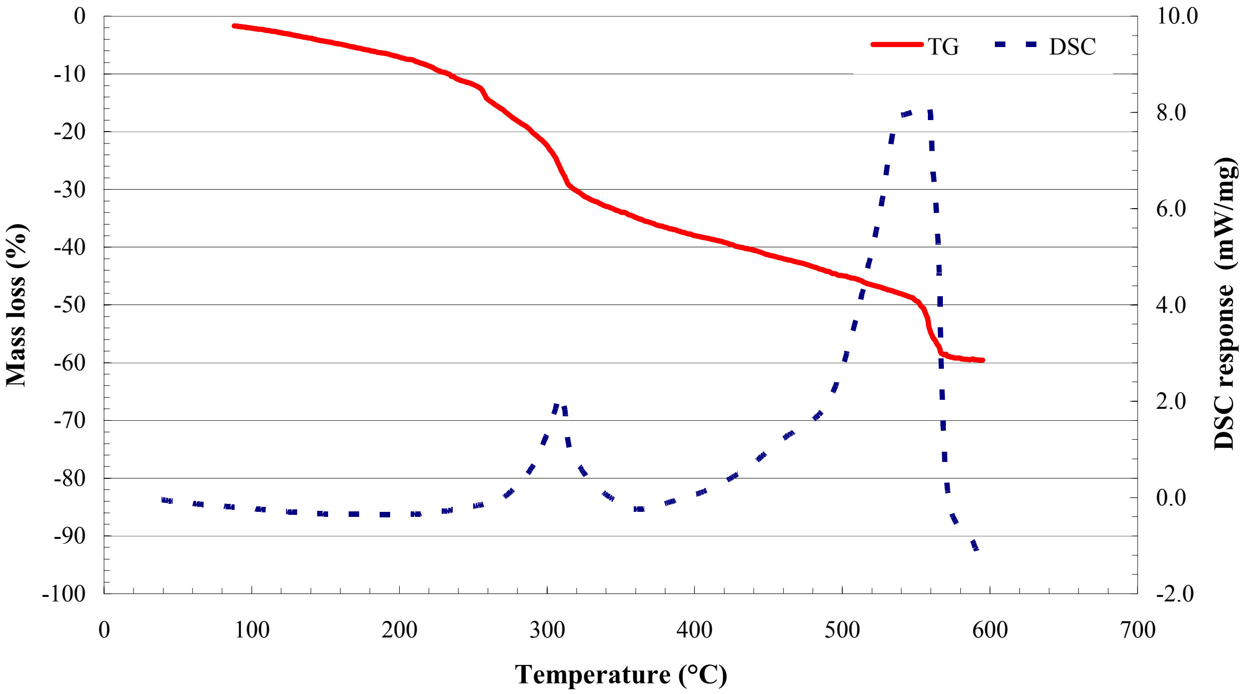
DSC/TGA scan of Fe gluconate



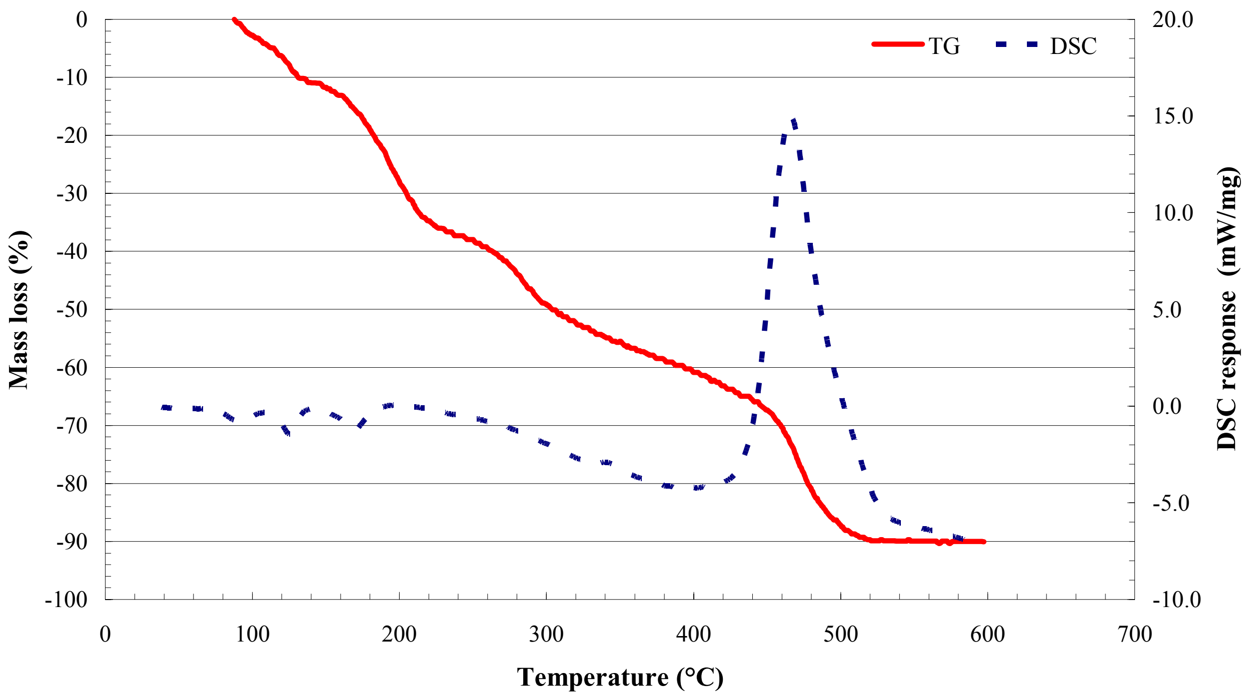
DSC/TGA scan of Mg gluconate



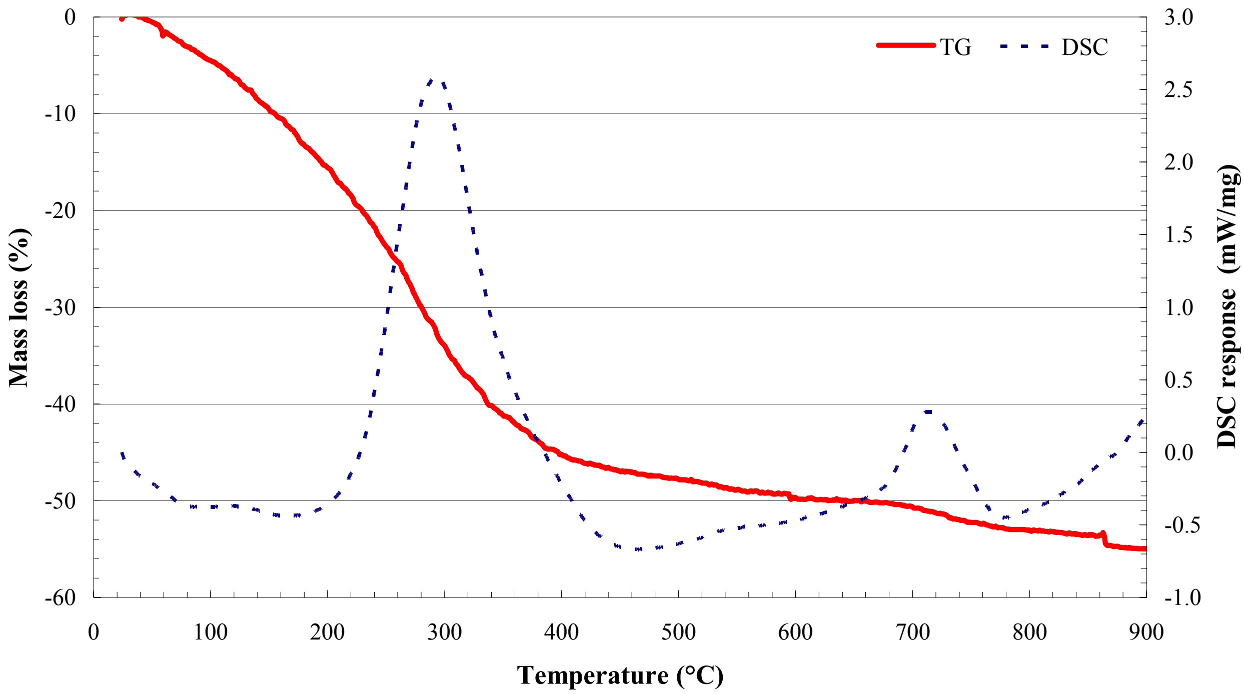
DSC/TGA scan of Na gluconate



DSC/TGA scan of Sb gluconate



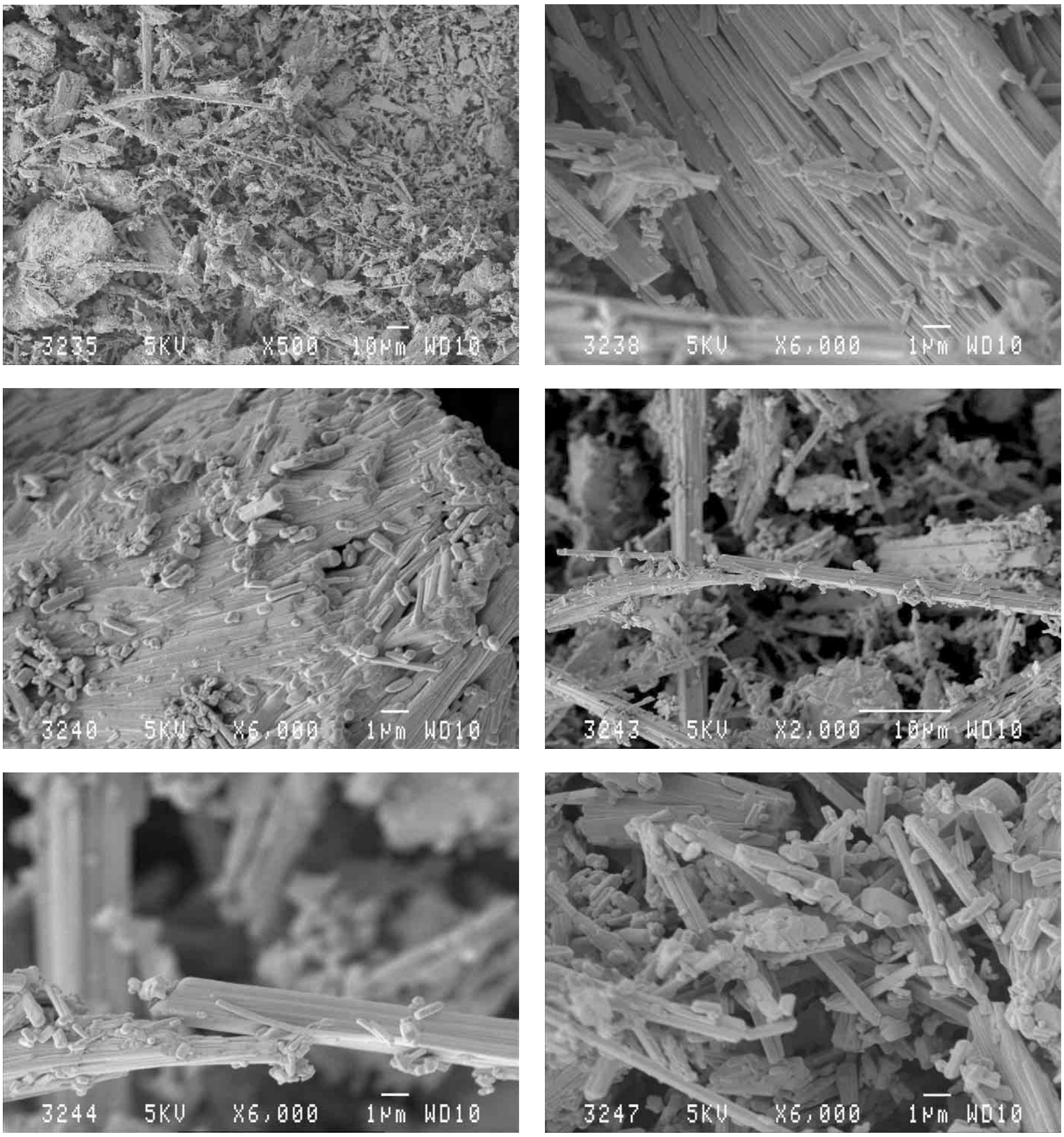
DSC/TGA scan of Zn gluconate



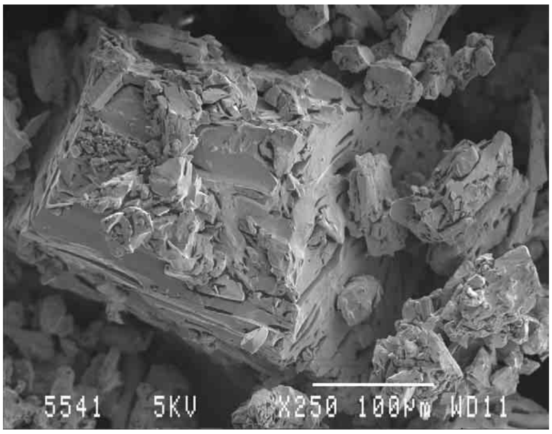
DSC/TGA scan of Zr gluconate

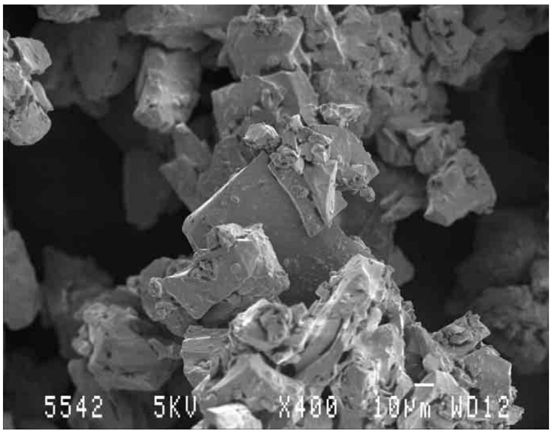
7.14. Appendix N

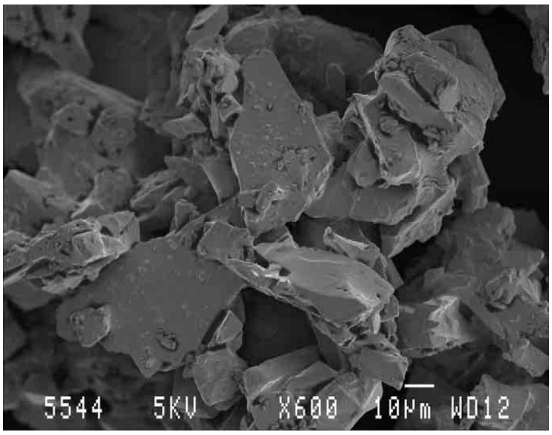
7.14.1. SEM images of calcium gluconate monohydrate powder (crystals).

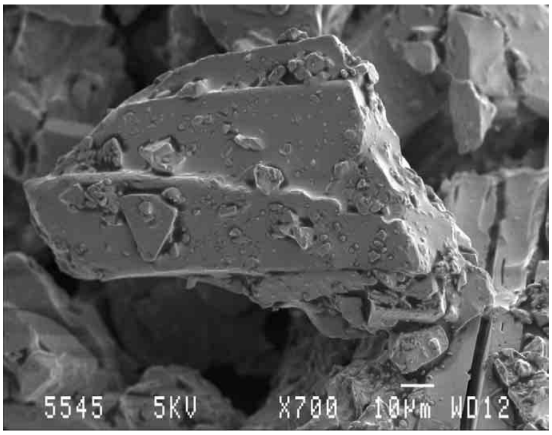


7.14.2. SEM images of ammonium gluconate hydrate (crystals).

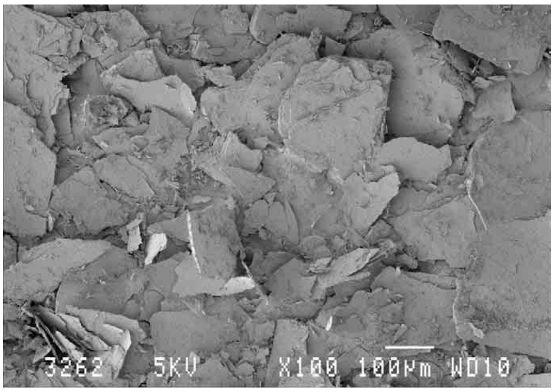


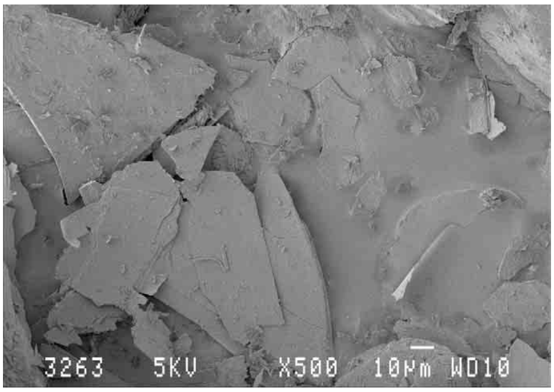


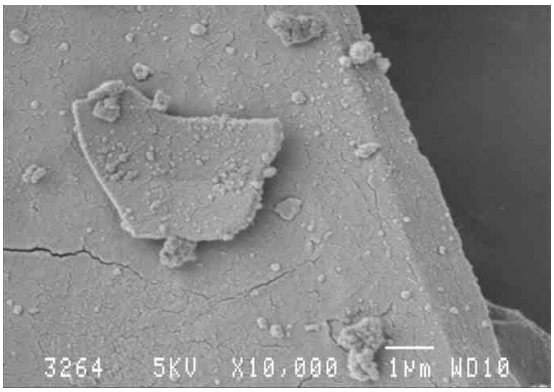


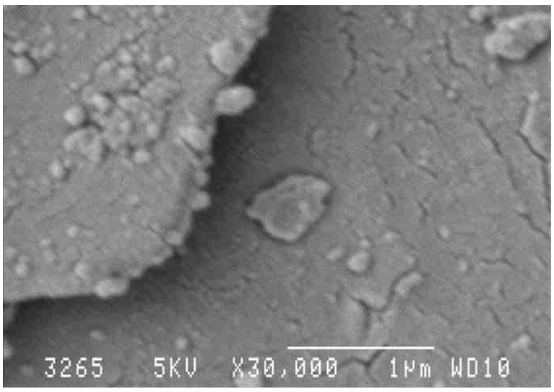


7.14.3. SEM images of the plate like leached SiO_2



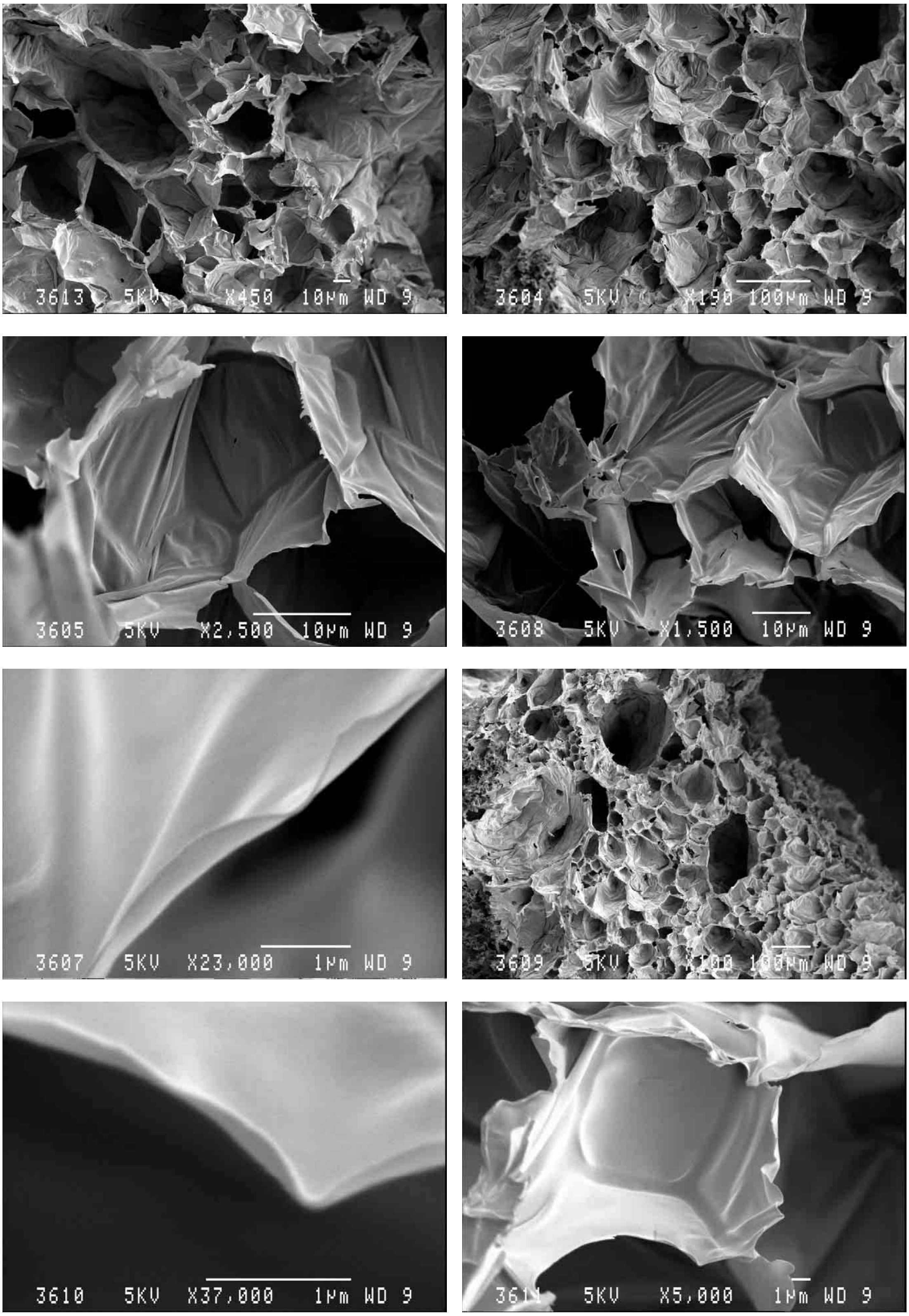




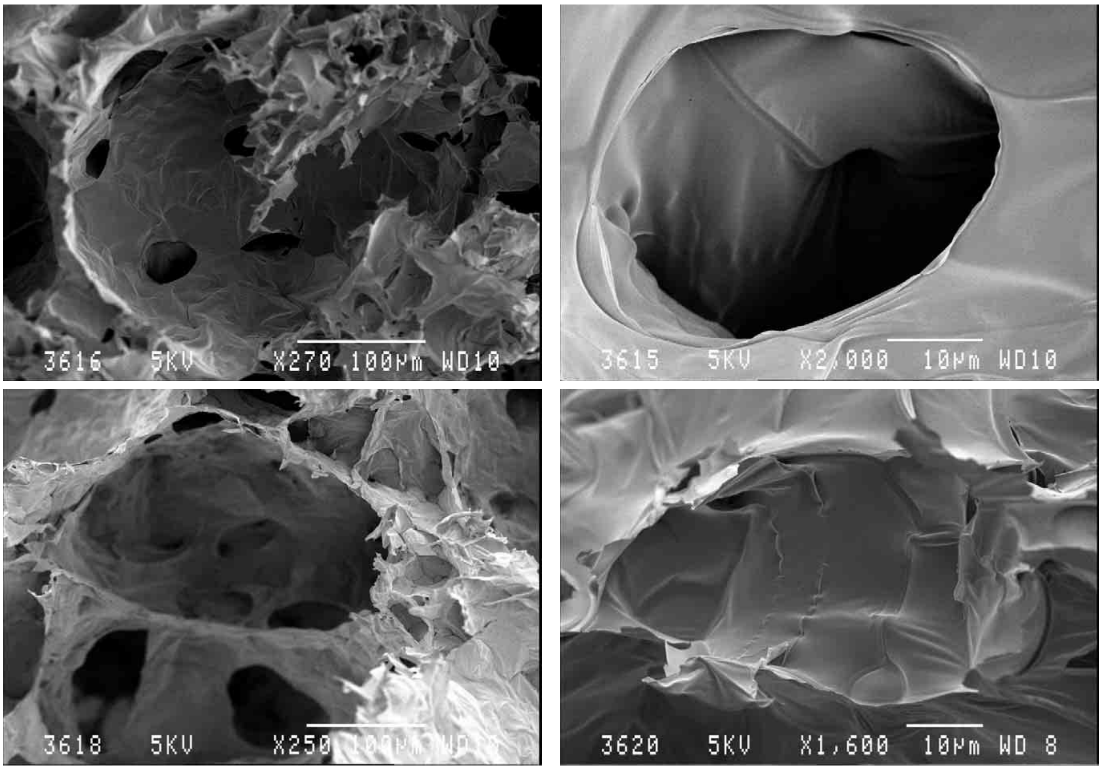


7.14.4. SEM images of calcium gluconate pyrolysed in air at selected temperatures

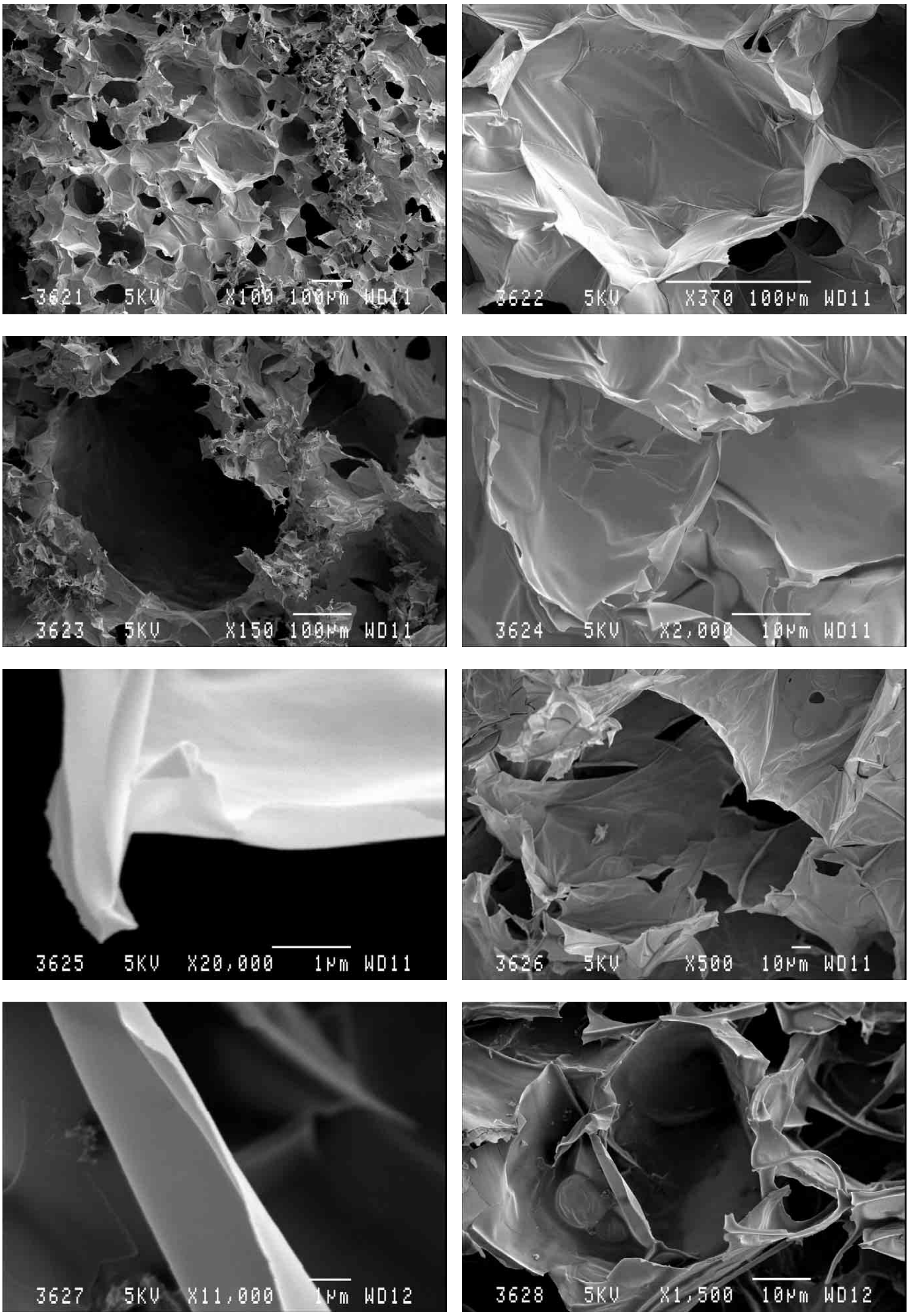
Calcium gluconate pyrolysed in air at 200 °C



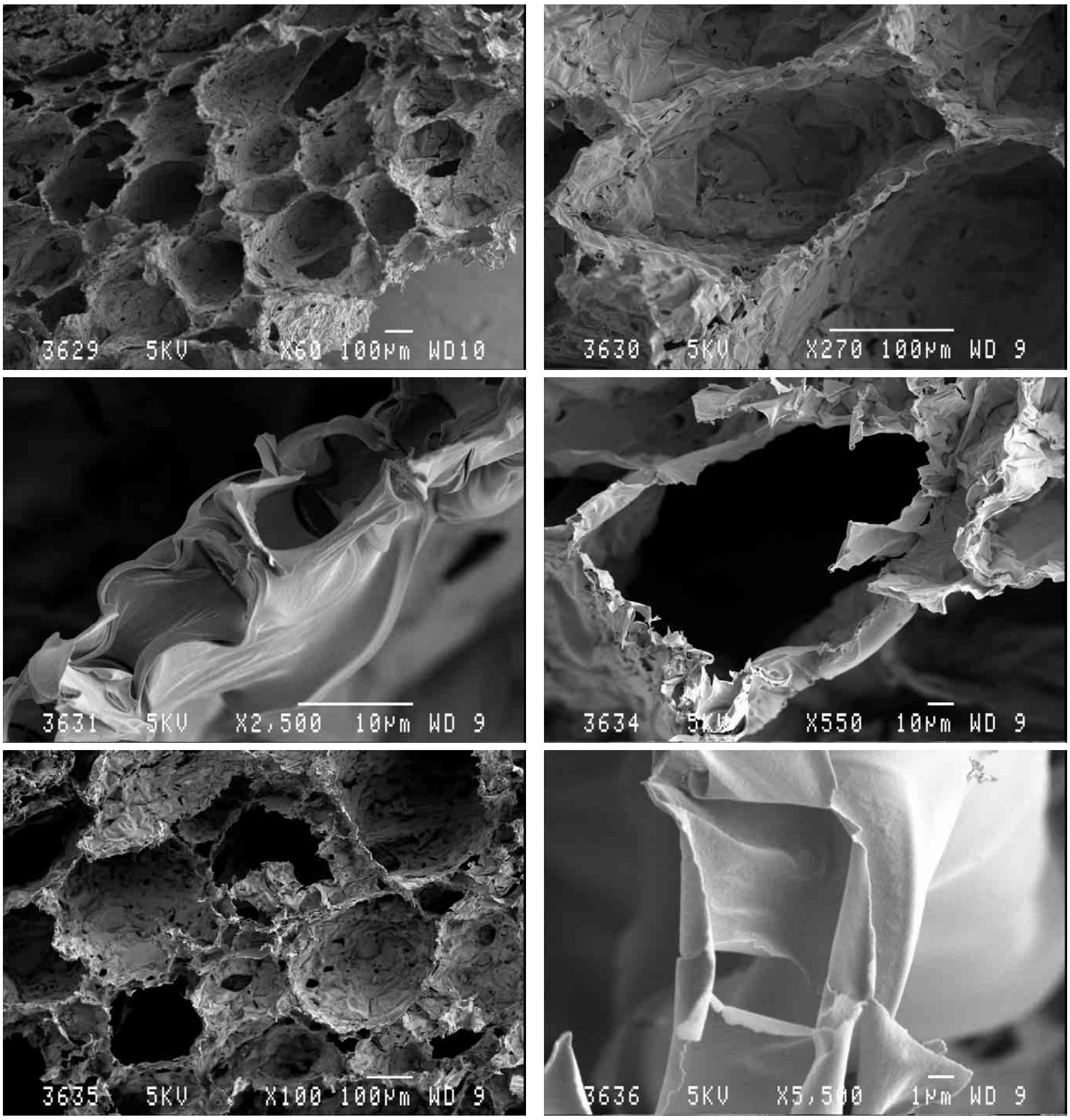
Calcium gluconate pyrolysed in air at 300 °C



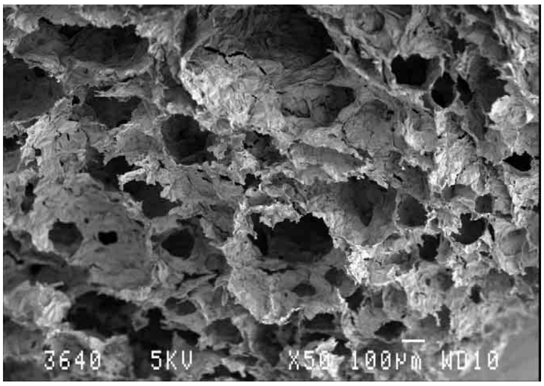
Calcium gluconate pyrolysed in air at 400 °C

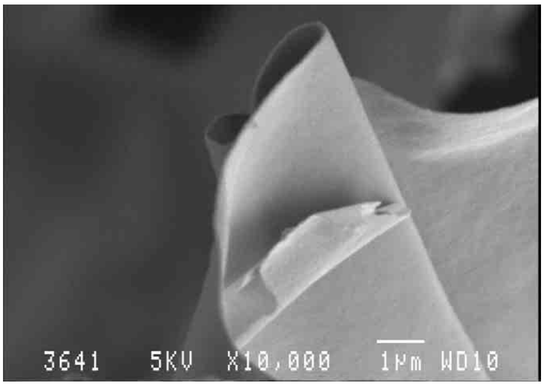


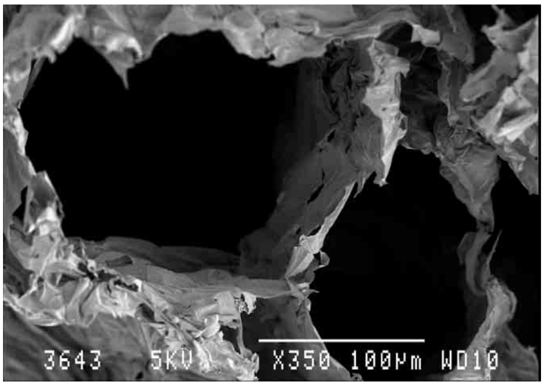
Calcium gluconate pyrolysed in air at 500 °C

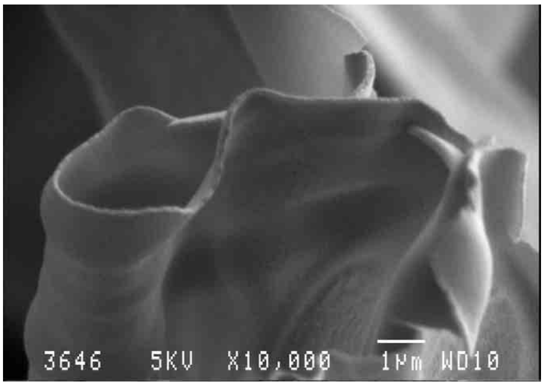


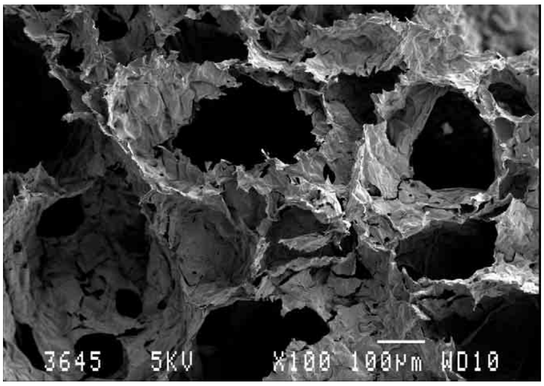
Calcium gluconate pyrolysed in air at 600 °C

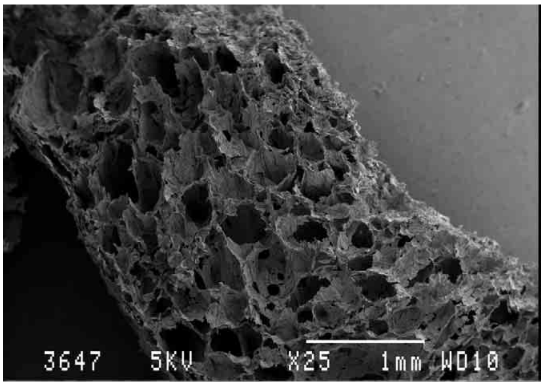




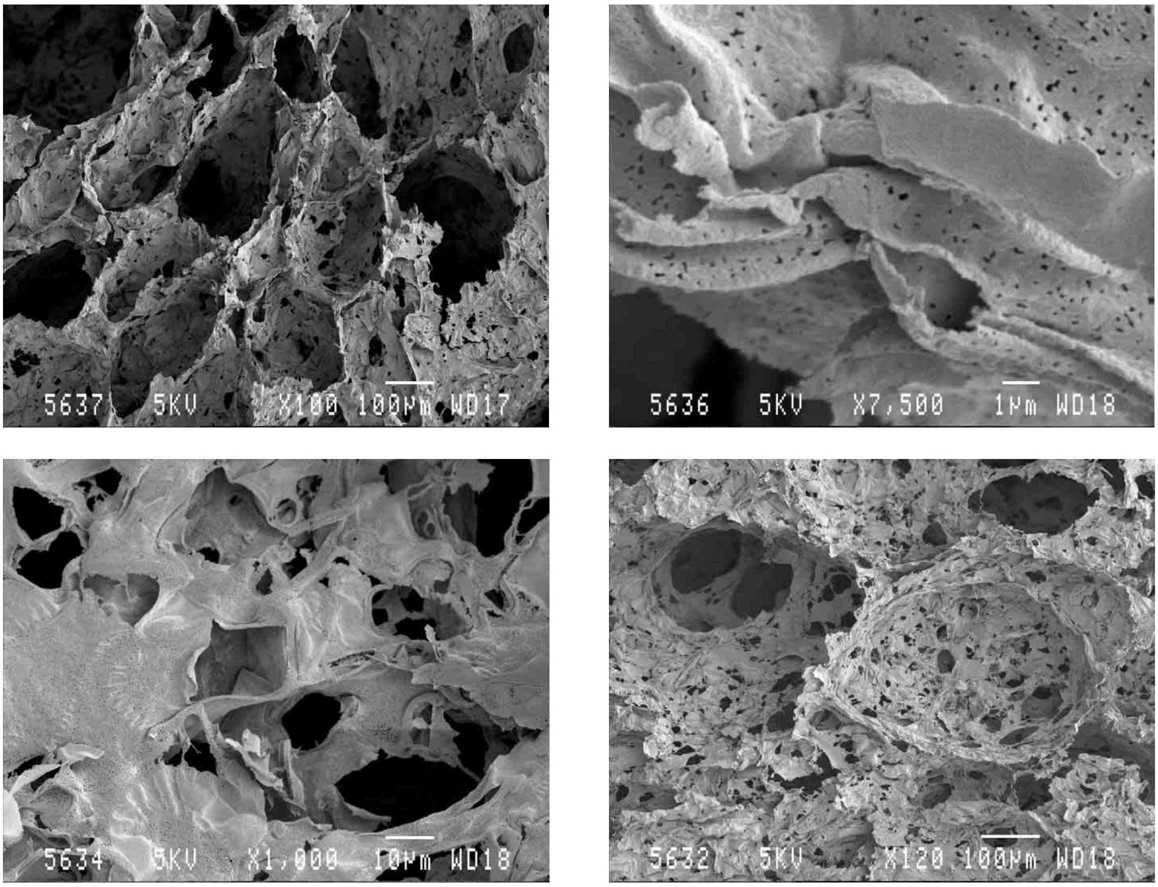




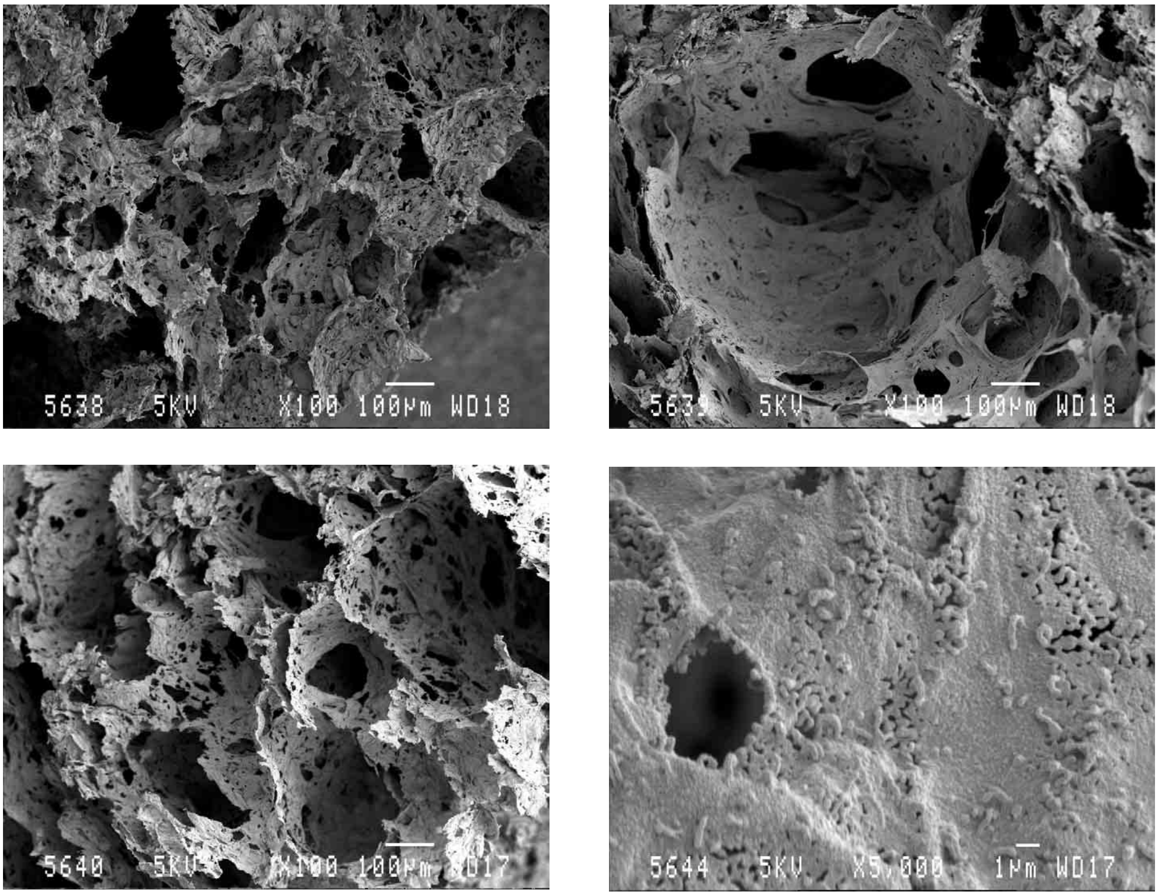




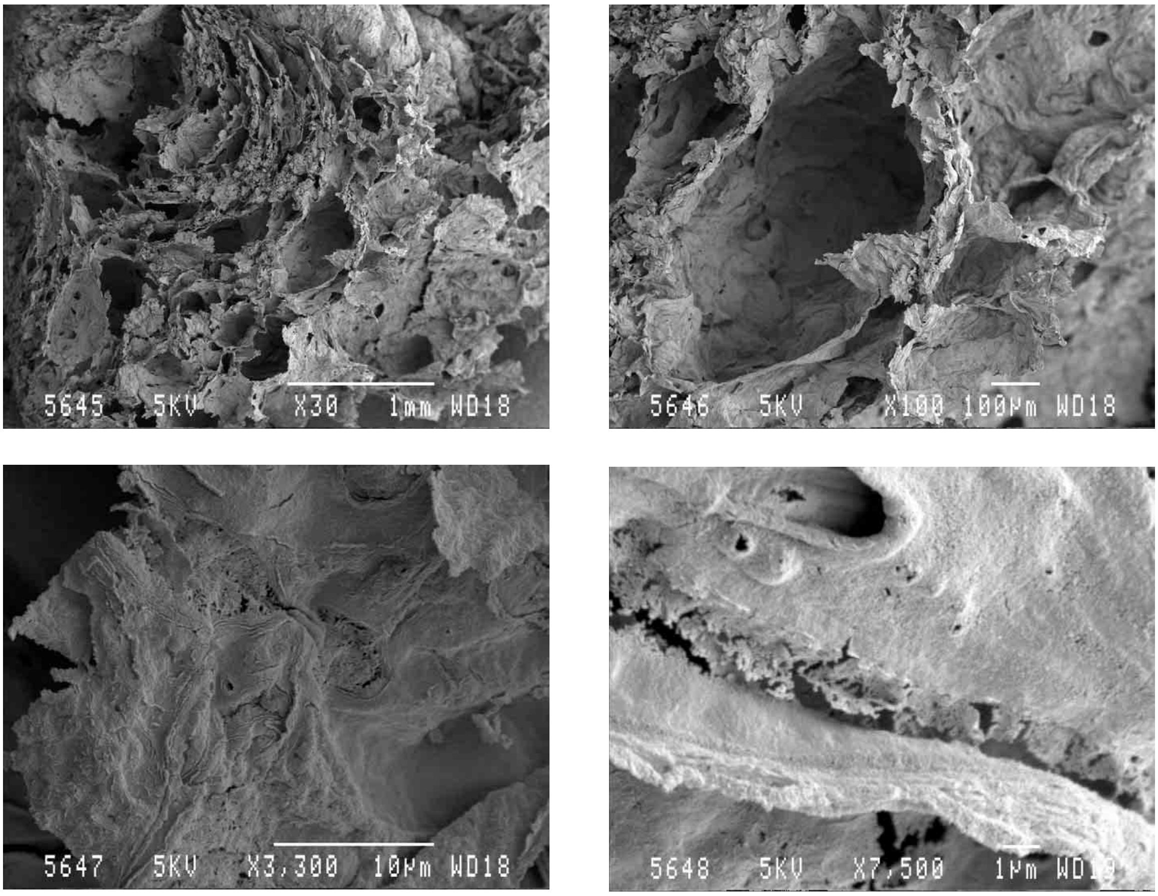
Calcium gluconate pyrolysed in air at 700 °C



Calcium gluconate pyrolysed in air at 800 °C

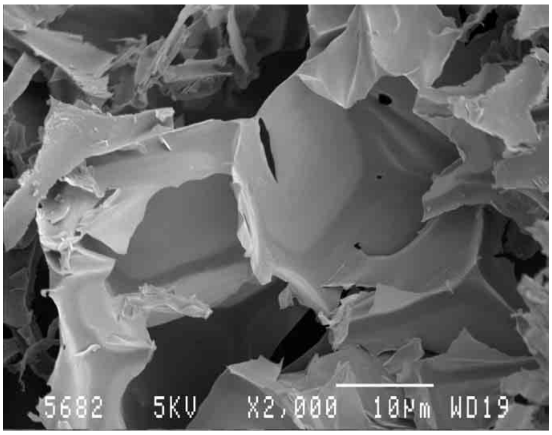


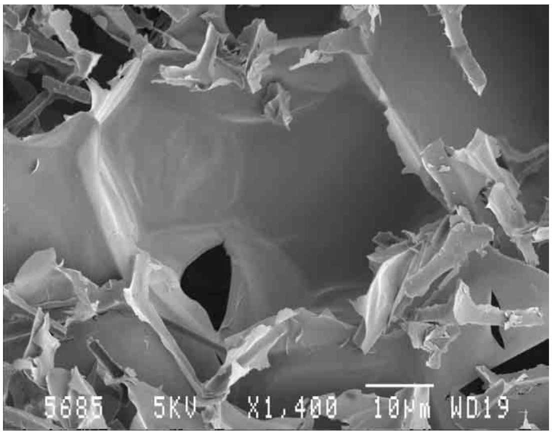
Calcium gluconate pyrolysed in air at 1000 °C

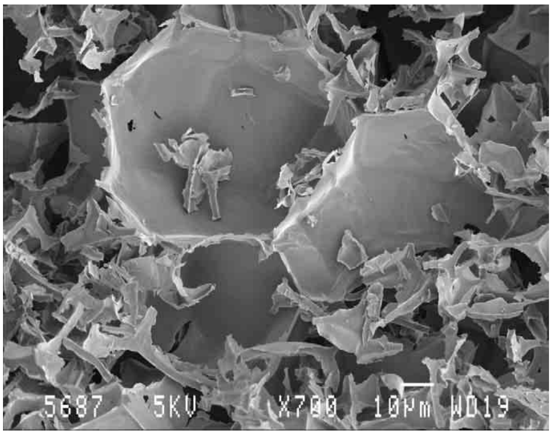


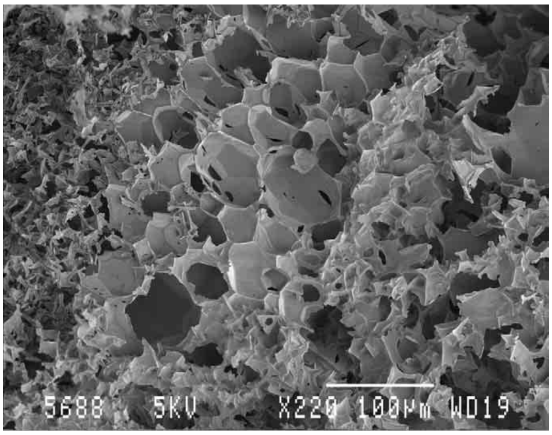
7.14.5. SEM images of calcium gluconate monohydrate pyrolysed in nitrogen at selected temperatures

Calcium gluconate pyrolysed in nitrogen at 200 °C

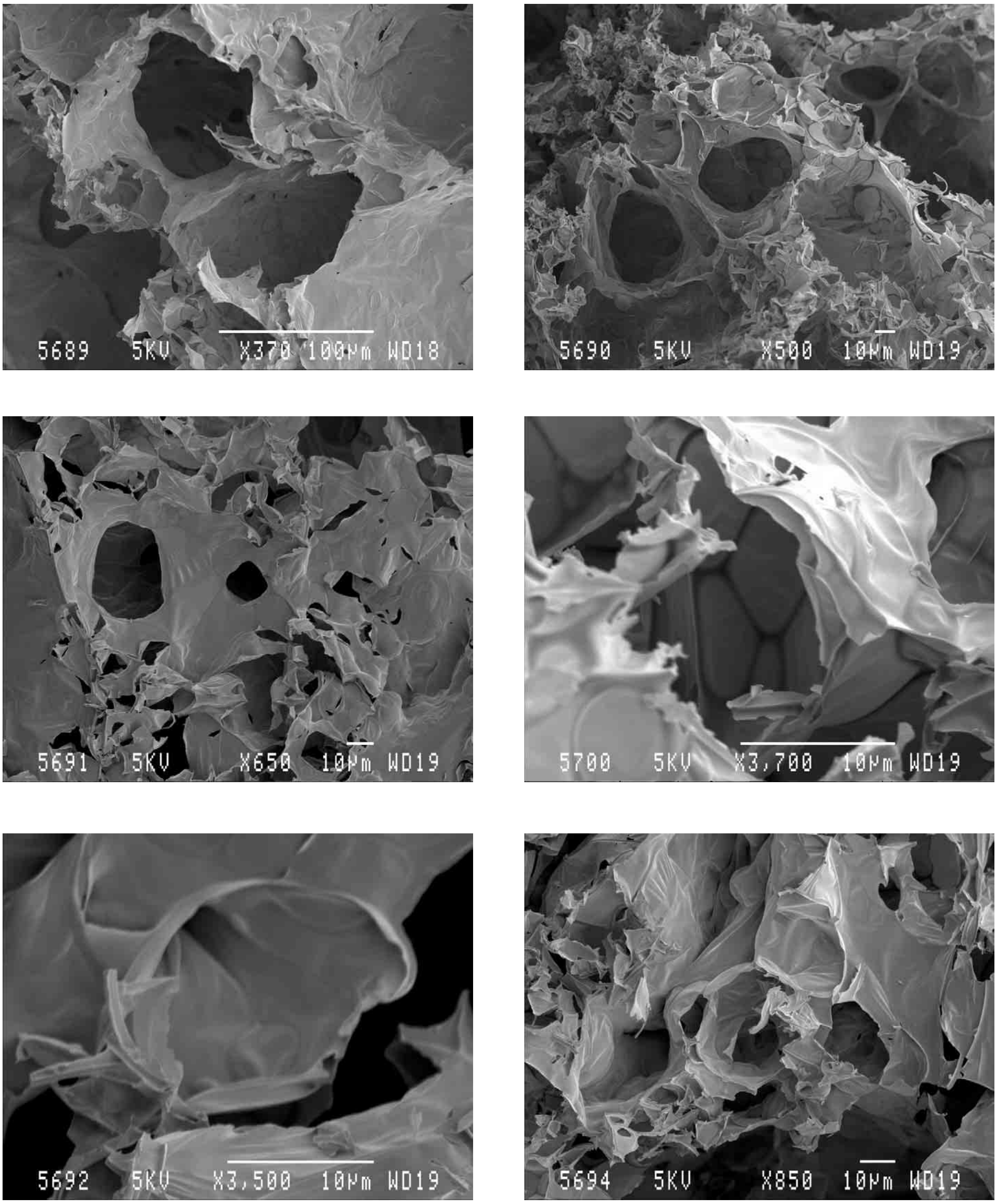




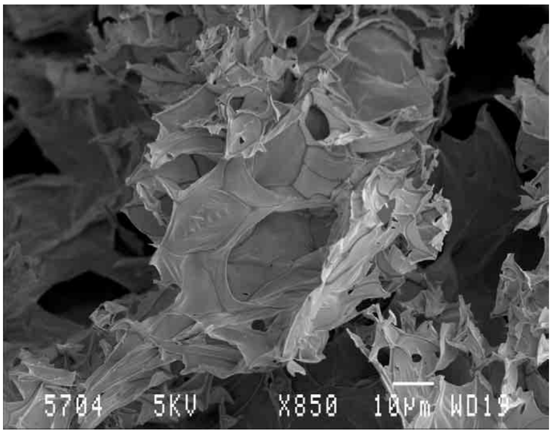


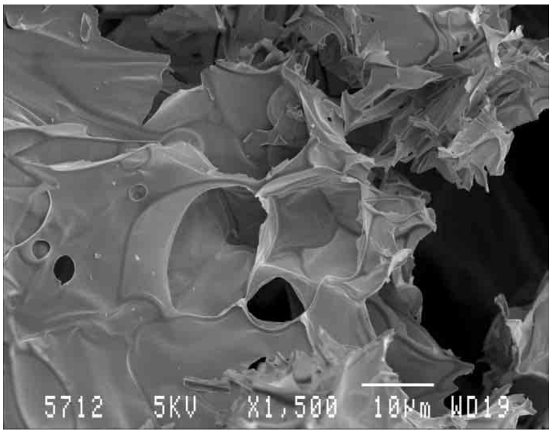


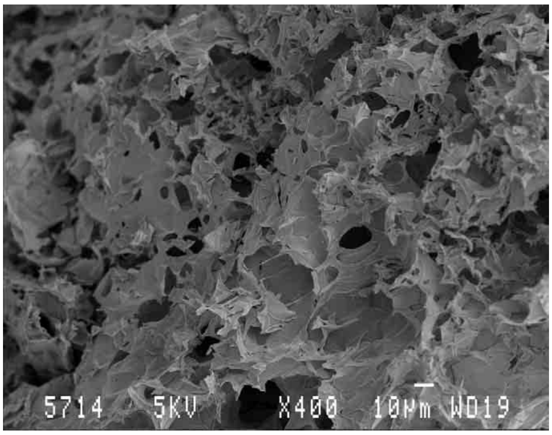
Calcium gluconate pyrolysed in nitrogen at 300 °C

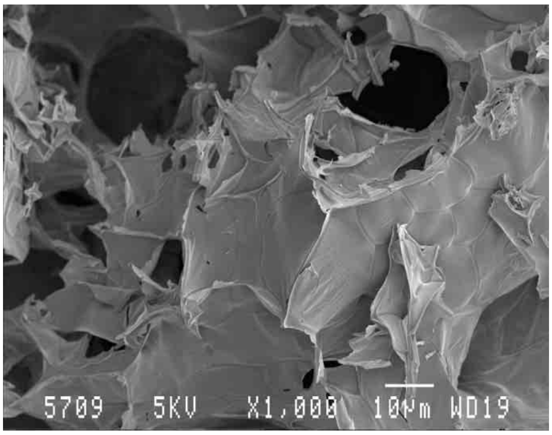


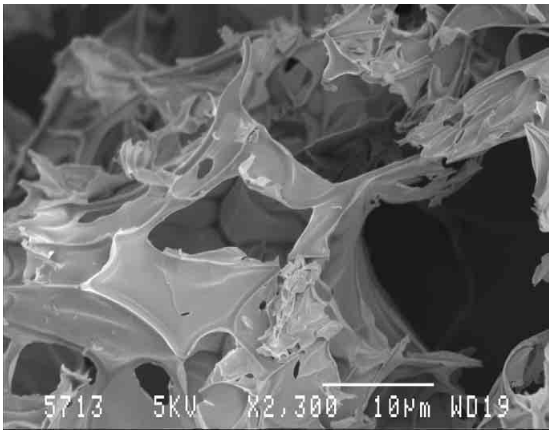
Calcium gluconate pyrolysed in nitrogen at 400 °C

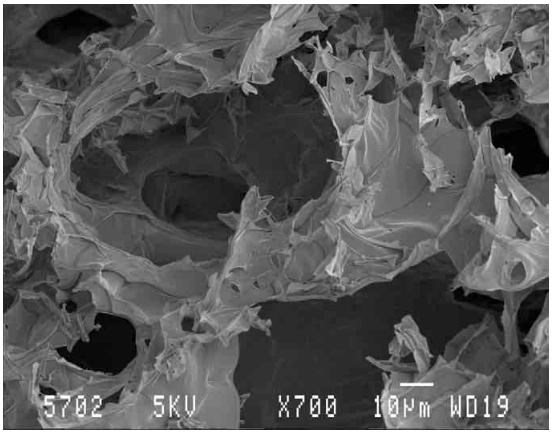




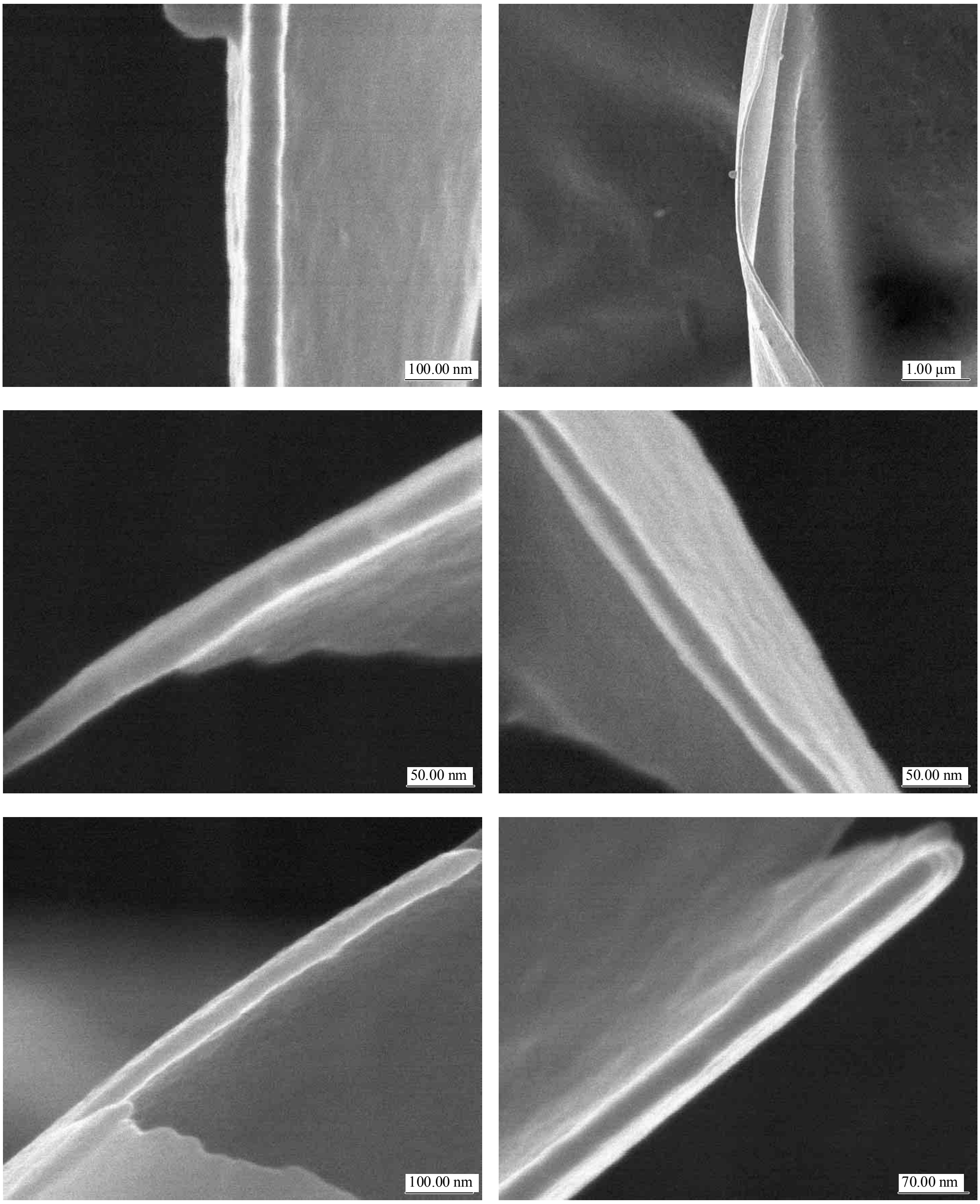






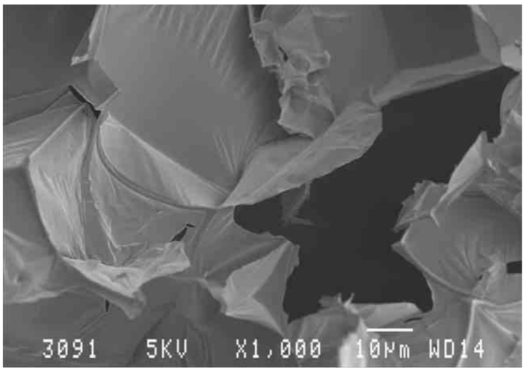


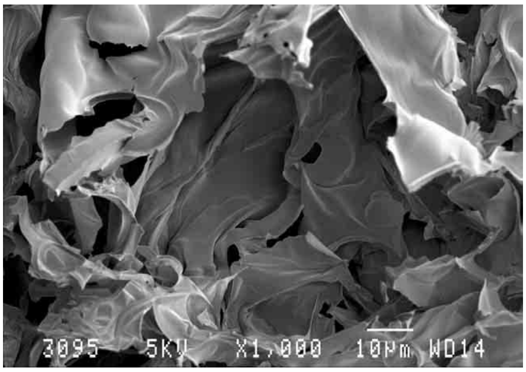
Wall thickness of calcium gluconate heated at 300°C

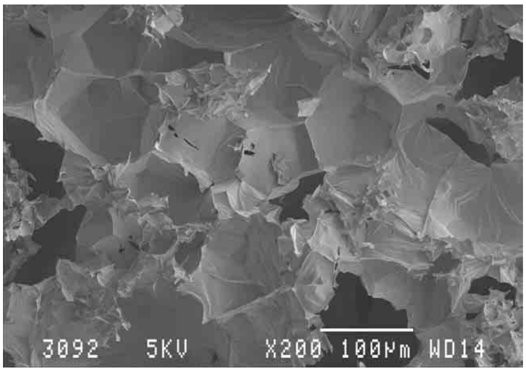


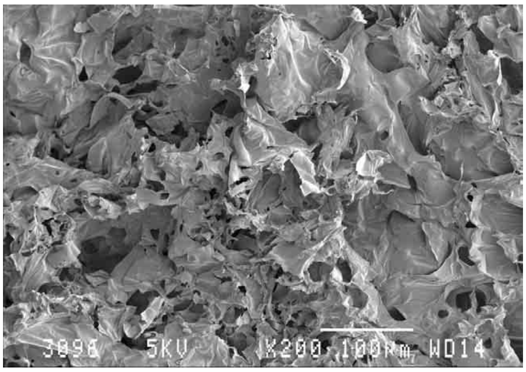
7.14.6. SEM images of calcium gluconate monohydrate and leached silica mixtures pyrolysed in air

4:1 mole ratio (gluconate: silica) heated at 400°C

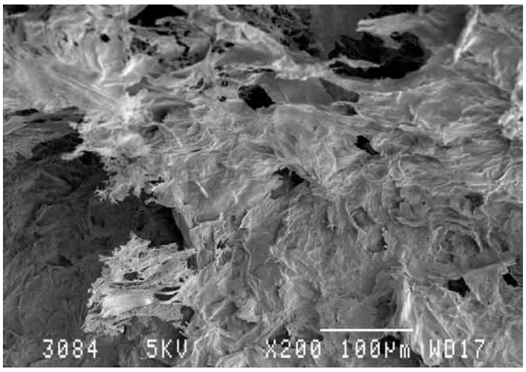


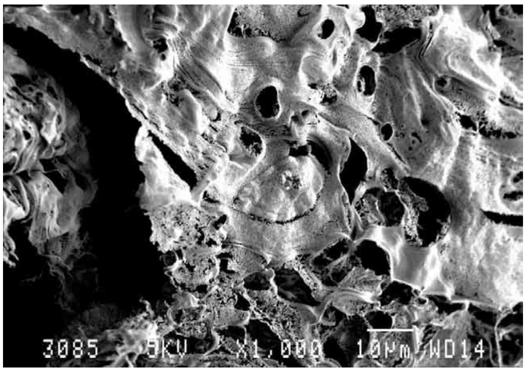




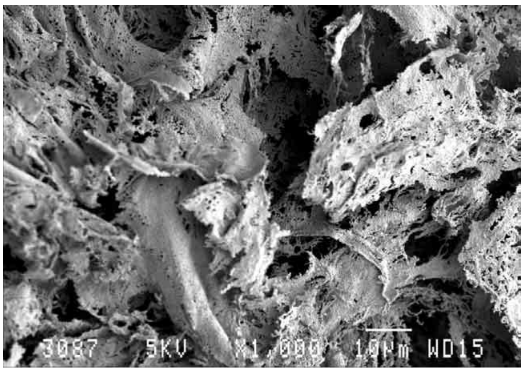


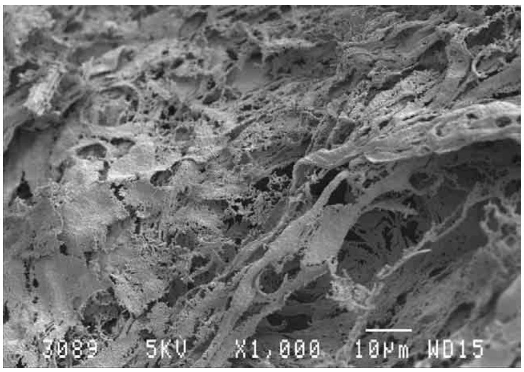
4:1 mole ratio (gluconate: silica) heated at 600°C



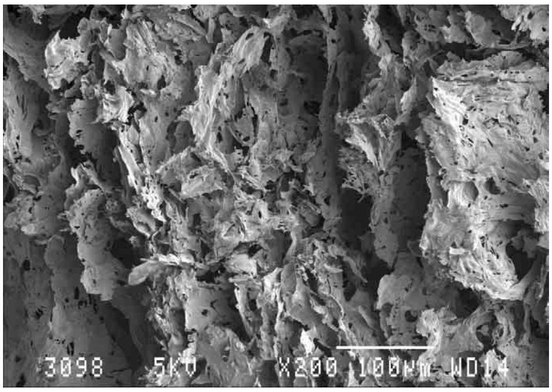


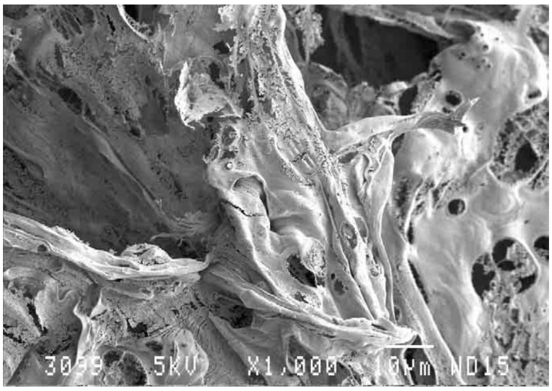
4:1 mole ratio (gluconate: silica) heated at 1000°C



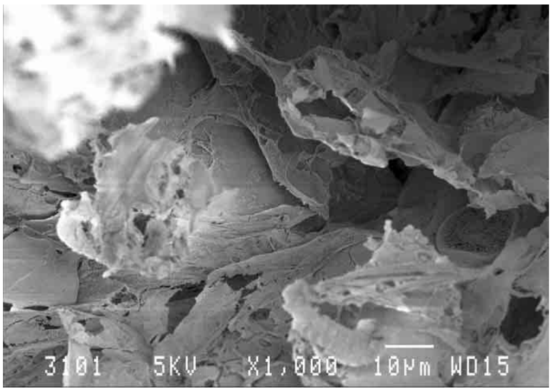


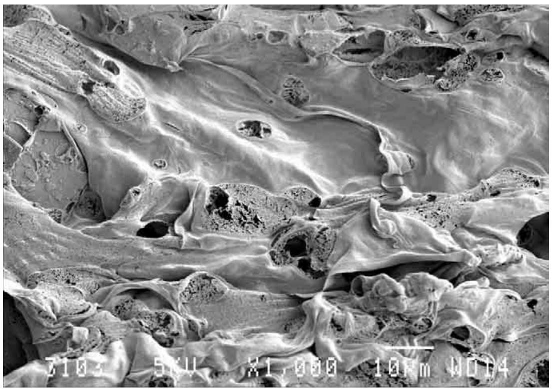
2:1 mole ratio (gluconate: silica) heated at 600°C

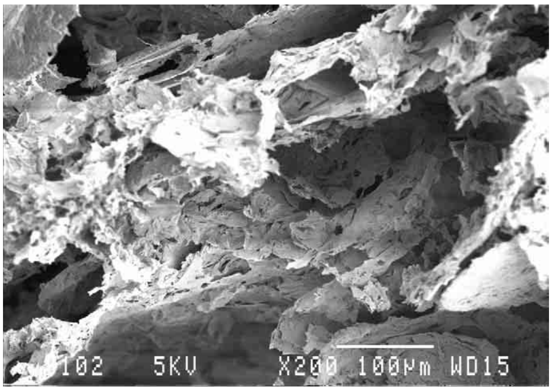


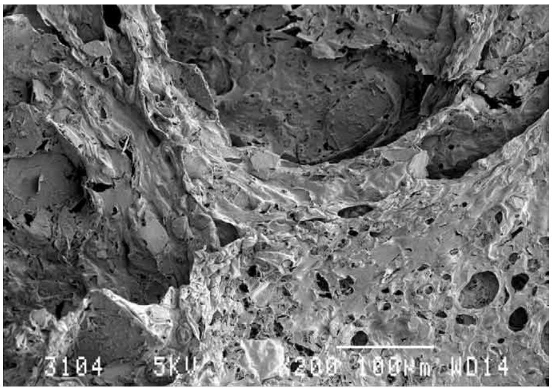


1:1 mass ratio (gluconate: silica) heated at 600°C



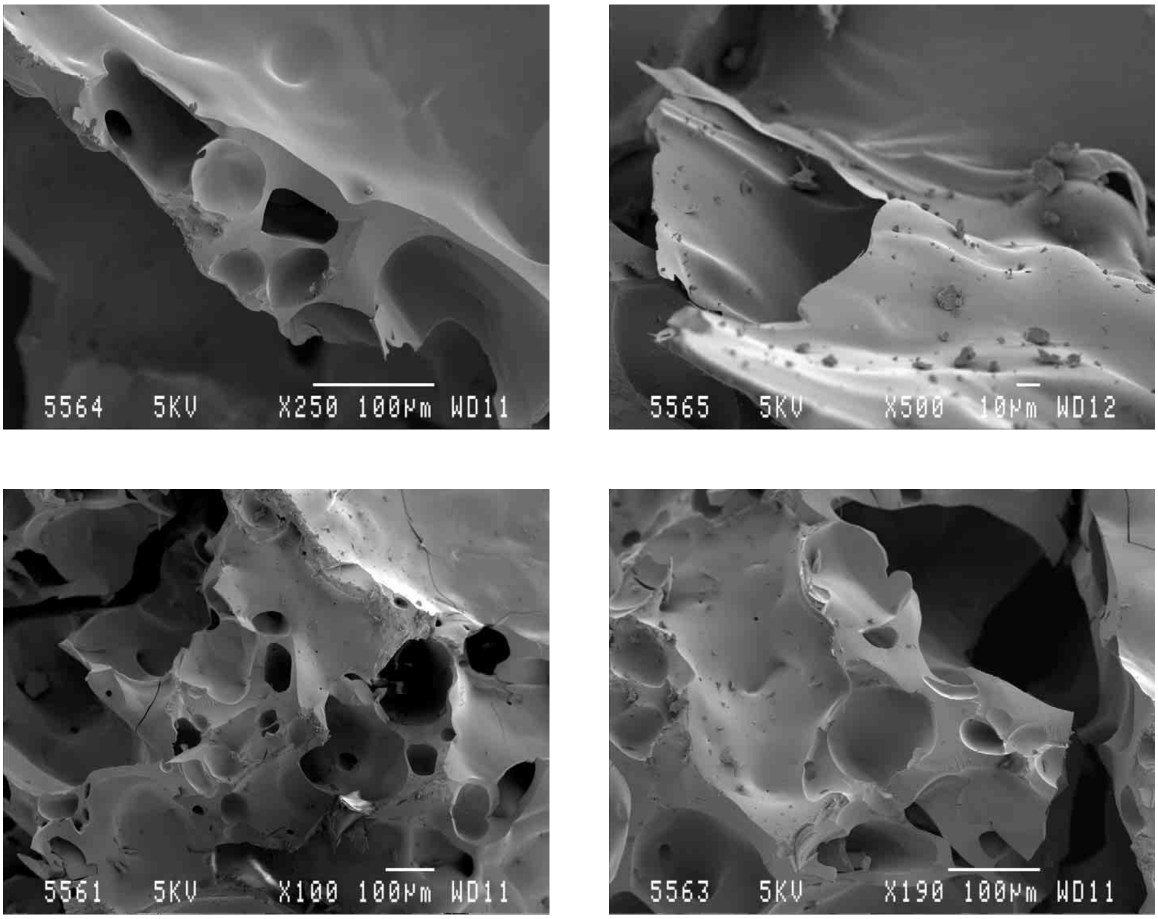




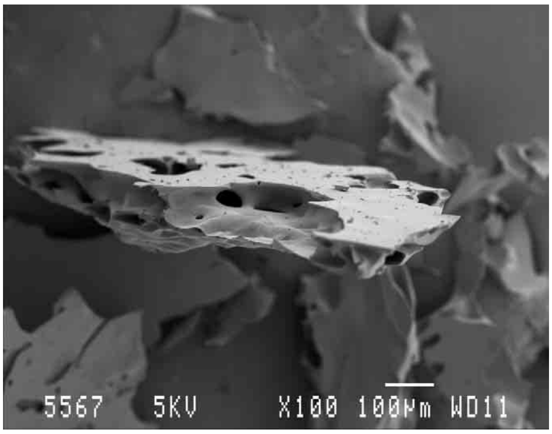


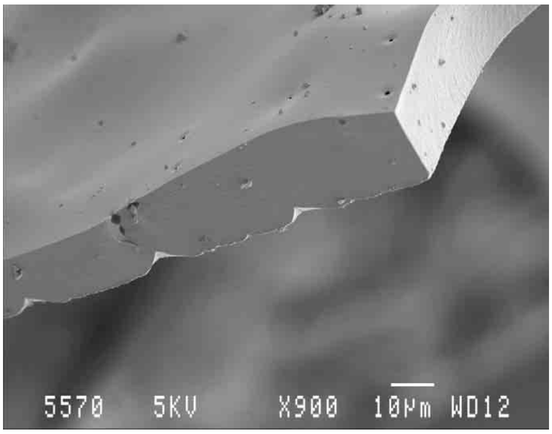
7.14.7. SEM images of ammonium gluconate hydrate pyrolysed in air at selected temperatures

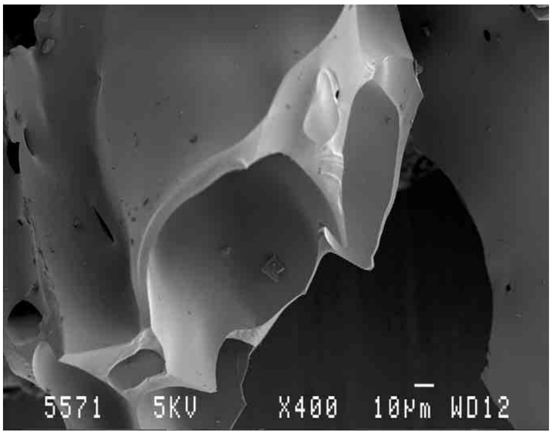
Ammonium gluconate pyrolysed in air at 300 °C

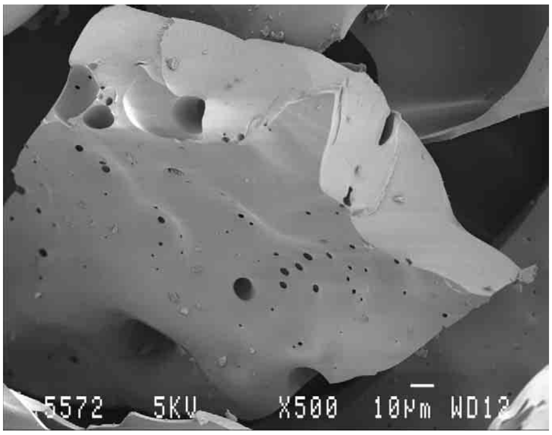


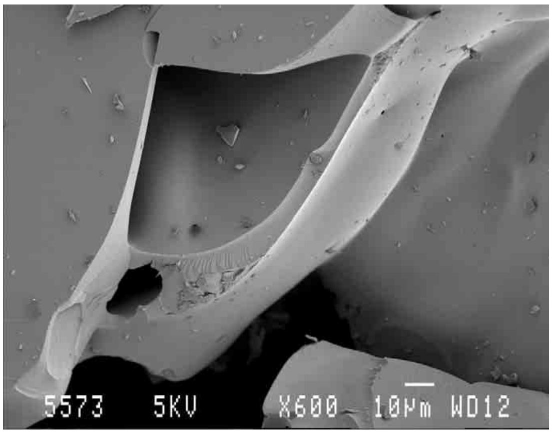
Ammonium gluconate pyrolysed in air at 400 °C

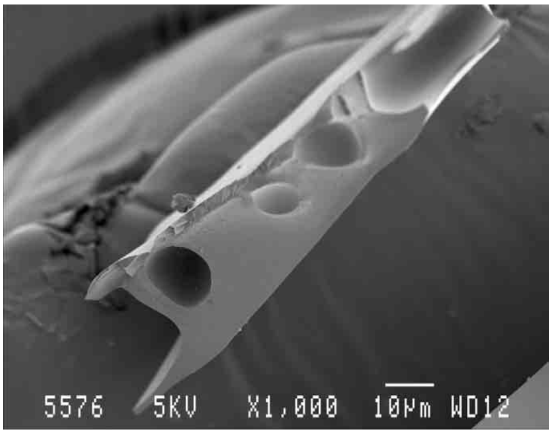






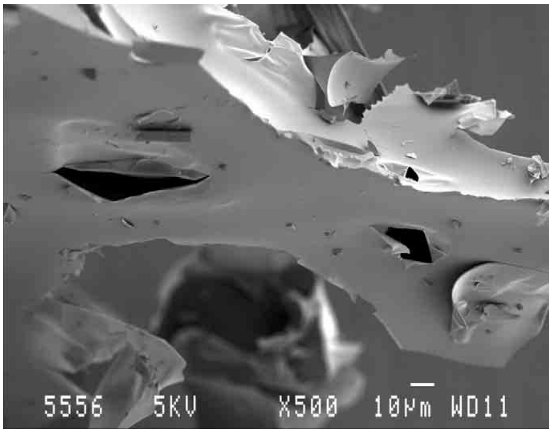


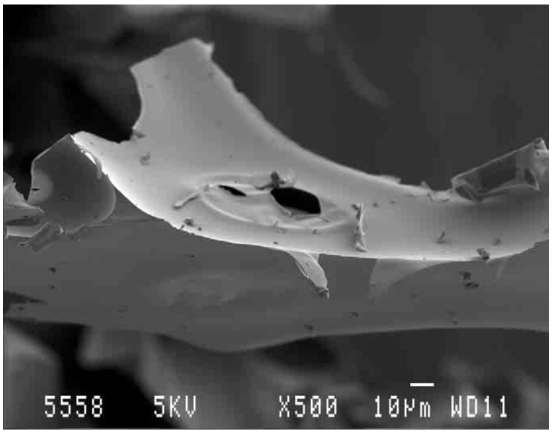


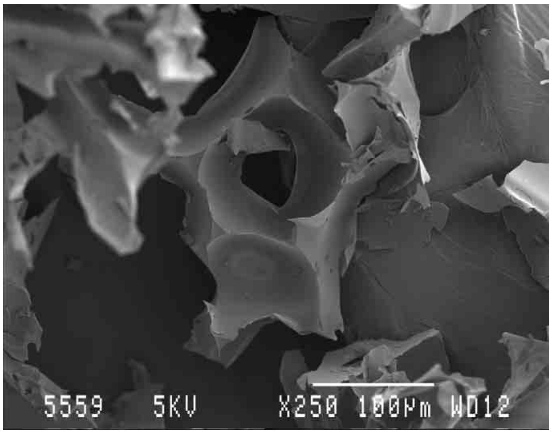


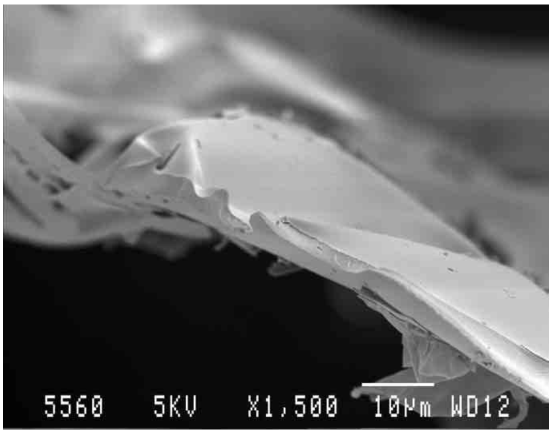
7.14.8. SEM images of ammonium gluconate hydrate pyrolysed in nitrogen at selected temperatures

Ammonium gluconate pyrolysed in nitrogen at 300 °C

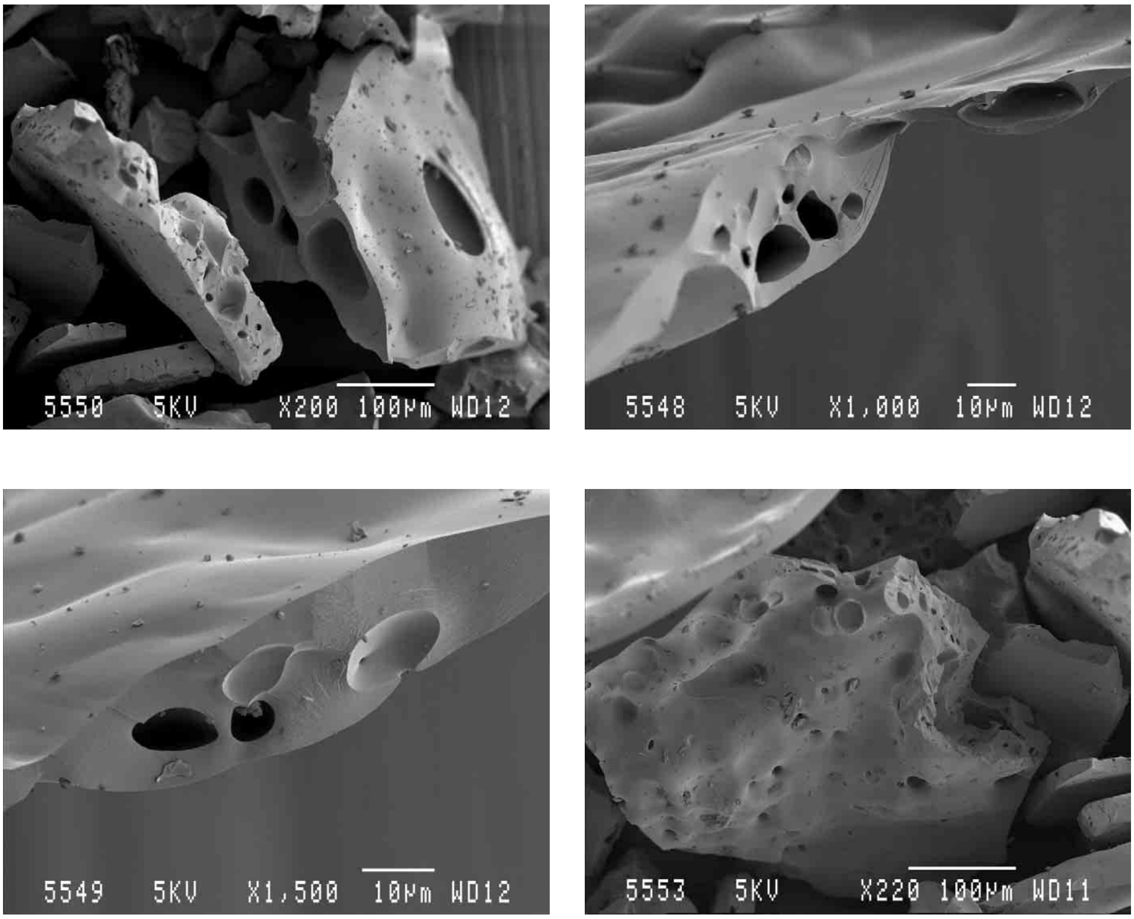




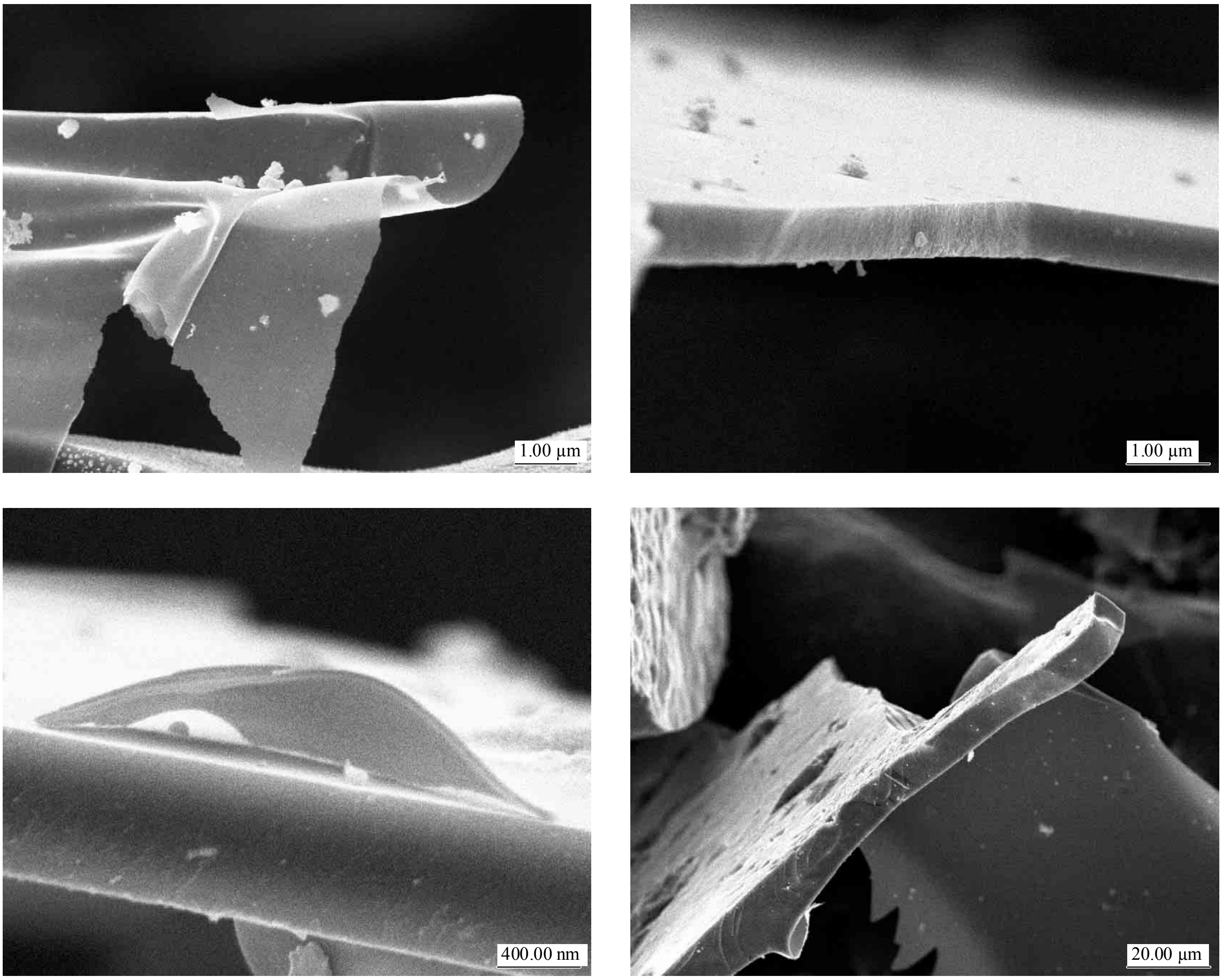




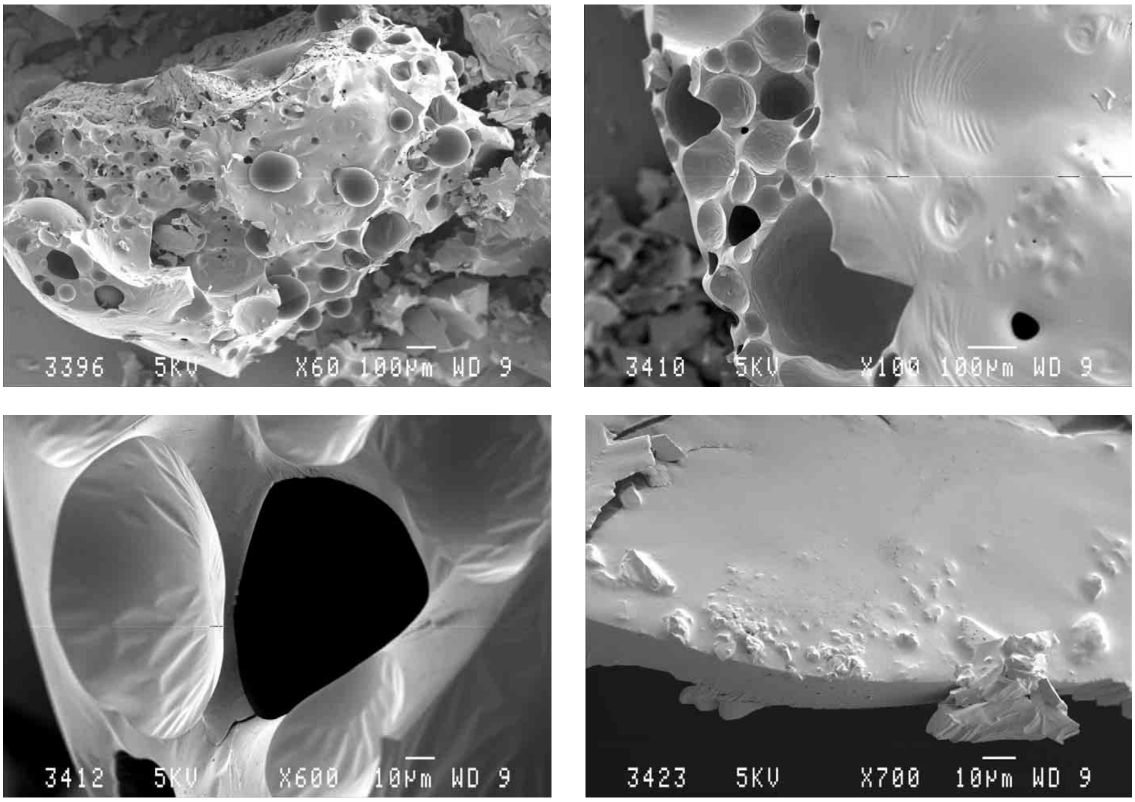
Ammonium gluconate pyrolysed in nitrogen at 400 °C



Wall thickness of ammonium gluconate heated at 300°C



7.14.9. SEM images of AP750 pyrolysed in air at 400 °C



7.14.10. SEM images of PEN pyrolysed in air at 400 °C