

BAUXITE RESIDUE VALORISATION AND BEST PRACTICES CONFERENCE

Leuven

5-7 October 2015



***The application of red mud as a
pre-catalyst for the formation of
functionalised carbons***



Aims of the British Council red mud project:

-Investigate red mud for cracking of CH_4 to produce H_2 and C



-Apply the C so produced to water purification

-Valorisation - two “waste” products generating two useful products

ICP analysis

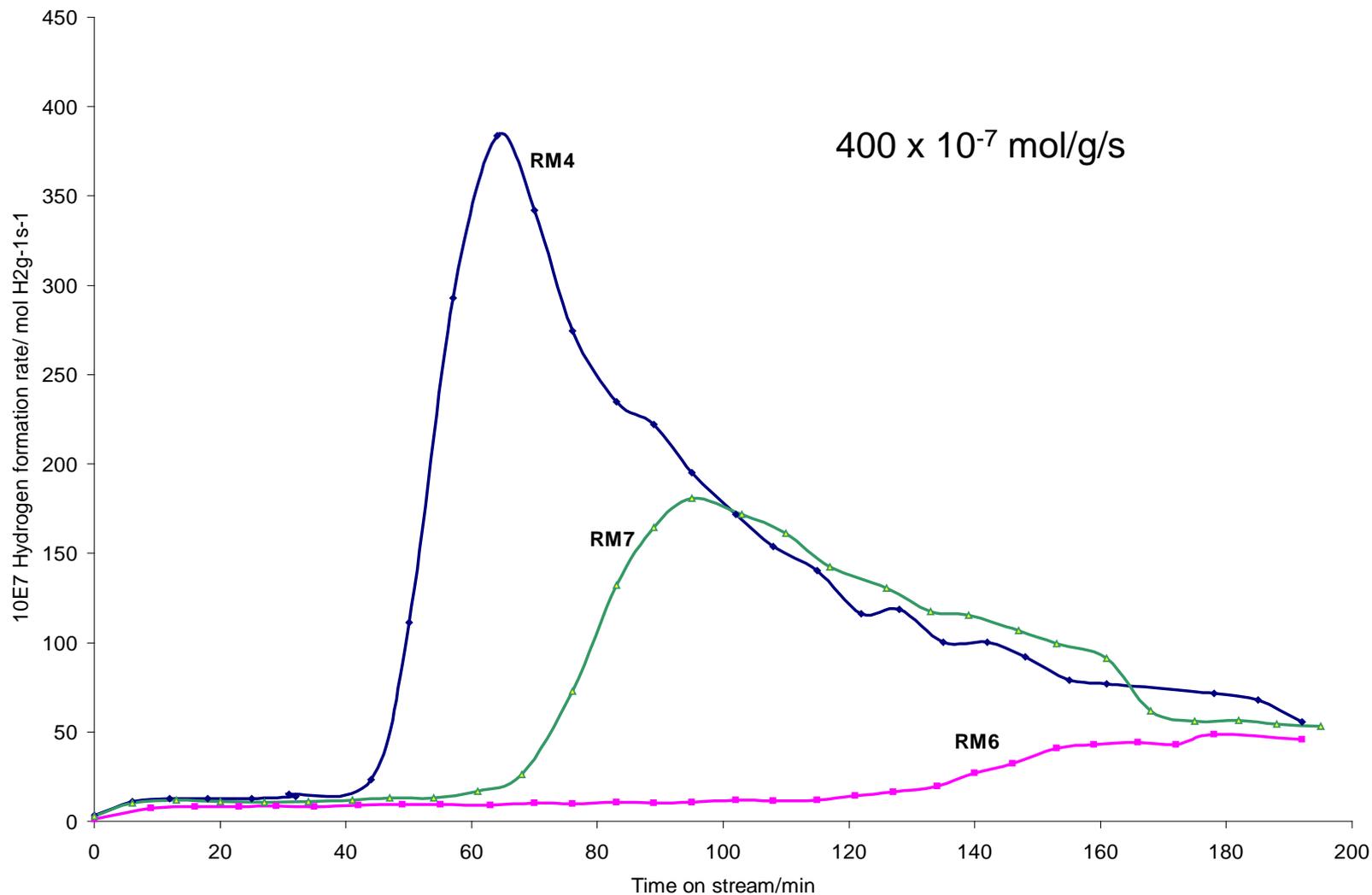
Elemental composition of red mud samples (wt %)

Sample code	Major elements										
	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	Na ₂ O	K ₂ O	P ₂ O ₅	MnO	LOI
RM4	16.40	10.44	42.70	6.44	2.85	1.56	3.72	0.05	0.02	-	15.30
RM6	12.40	10.12	36.40	18.70	2.65	2.52	3.85	0.09	0.02	-	12.80
RM 7	14.60	23.51	36.79	0.74	1.18	0.07	6.08	0.02	0.15	0.12	16.47

RM4 & RM7 same site but 24 month interval

RM4 15 m²g⁻¹, RM6 8 m²g⁻¹ & RM7 14 m²g⁻¹

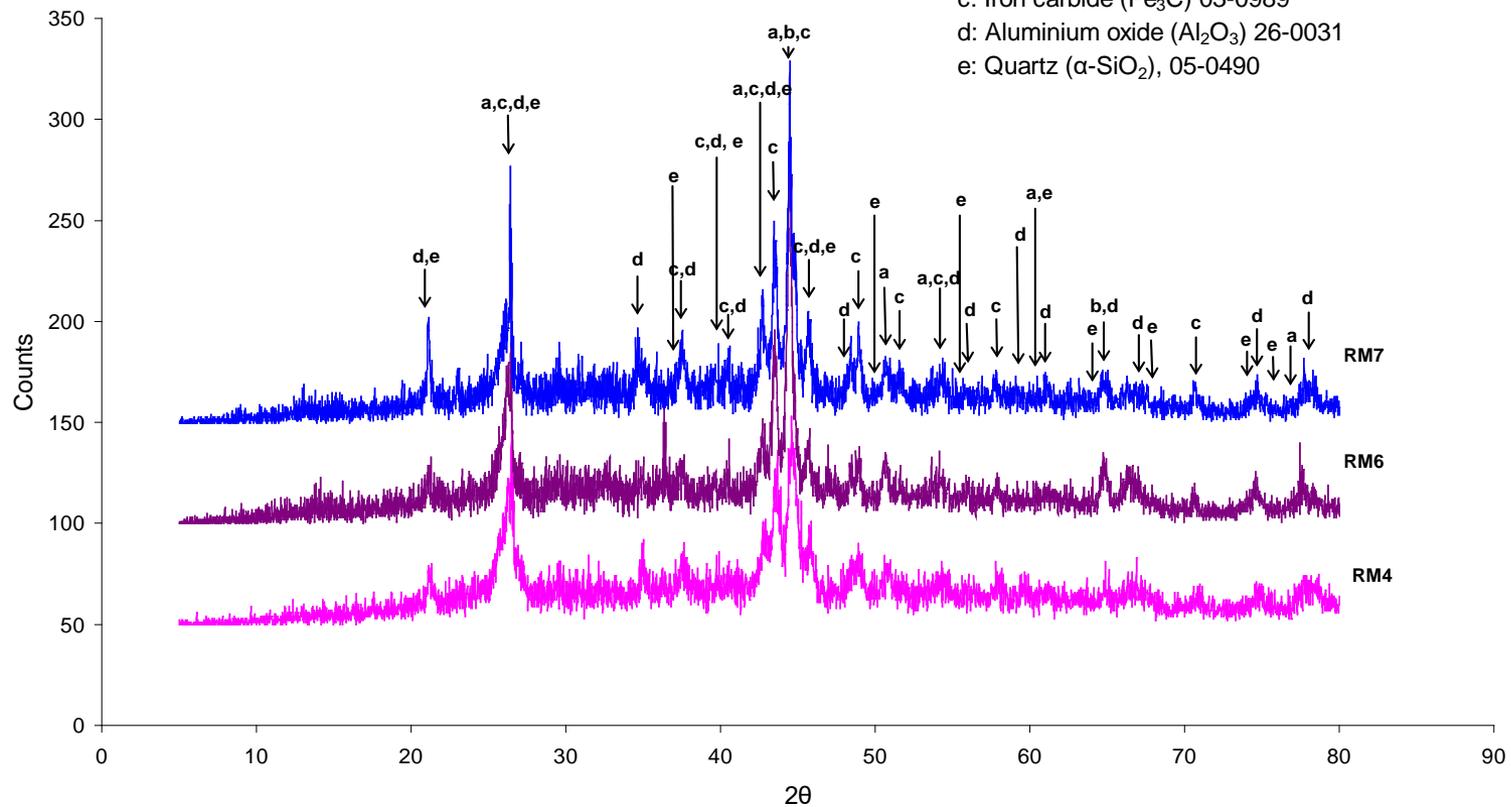
Mass normalised hydrogen formation rates at 800°C



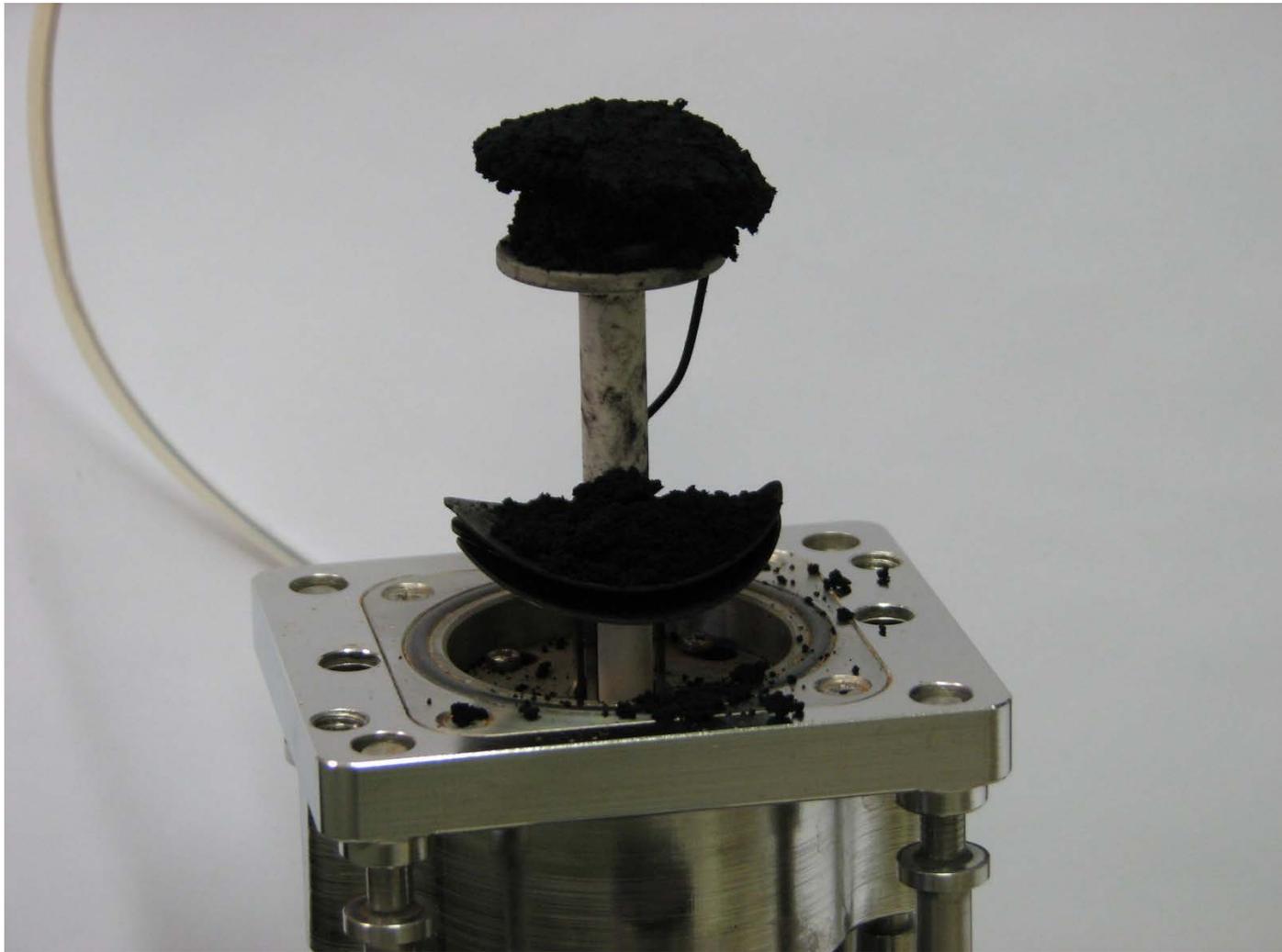
CH₄:N₂ =80:20, 60ml min⁻¹, 0.4g

Post 800°C reaction XRD analysis

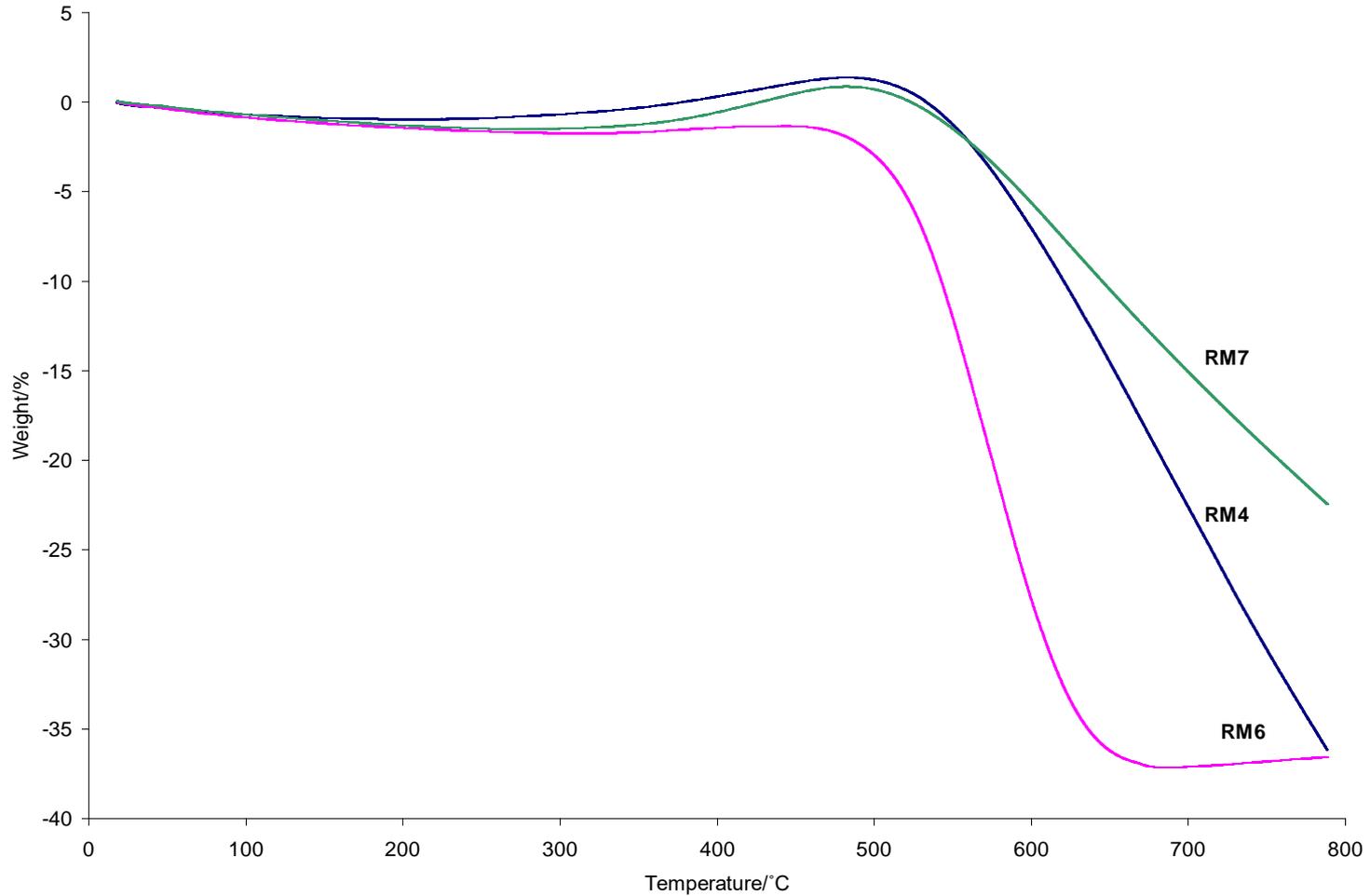
- a: Graphite (C) 23-0064
- b: Iron (Fe) 03-1050
- c: Iron carbide (Fe_3C) 03-0989
- d: Aluminium oxide (Al_2O_3) 26-0031
- e: Quartz ($\alpha\text{-SiO}_2$), 05-0490



RM 7 *in-situ* XRD, 72wt%C

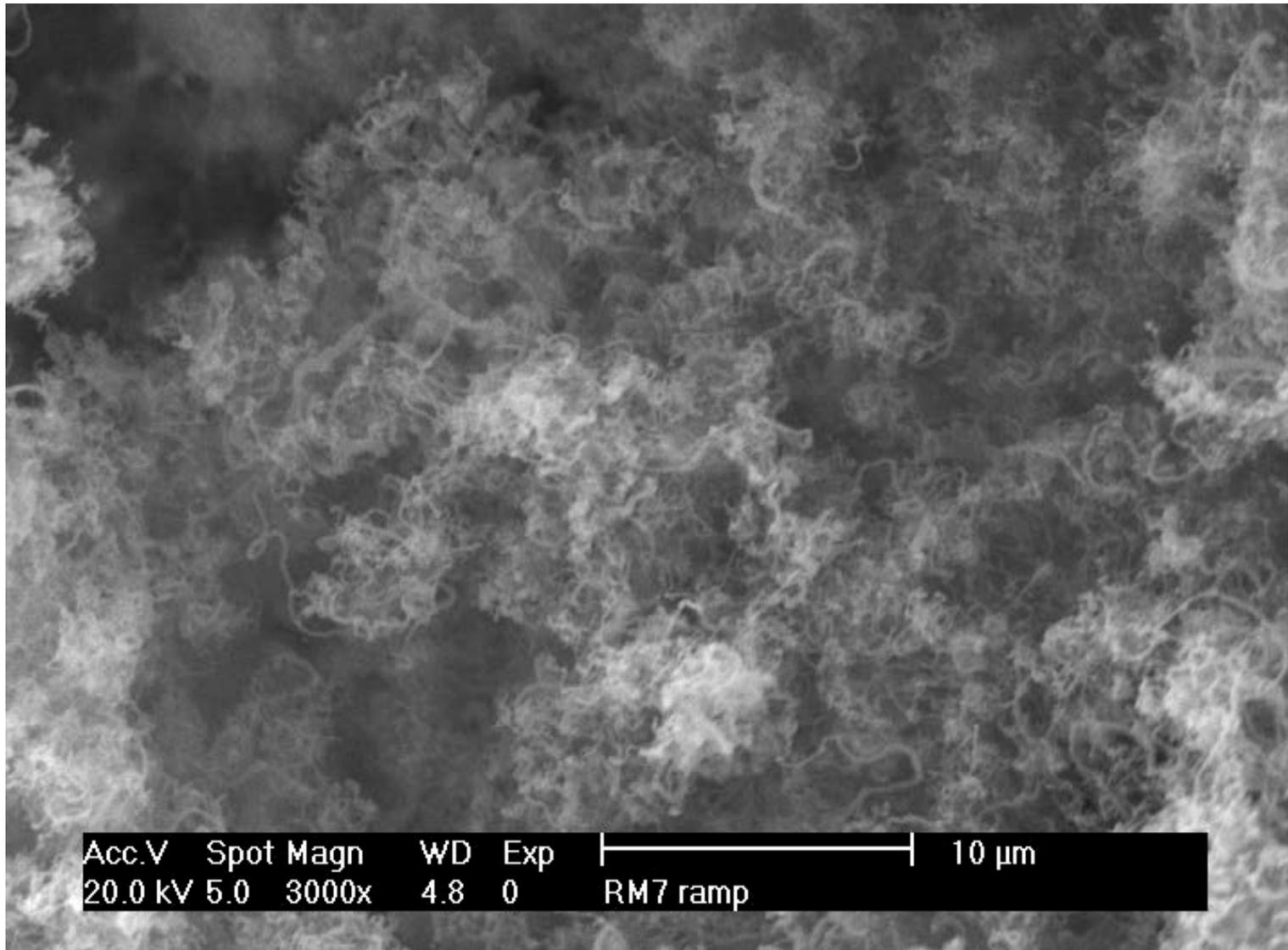


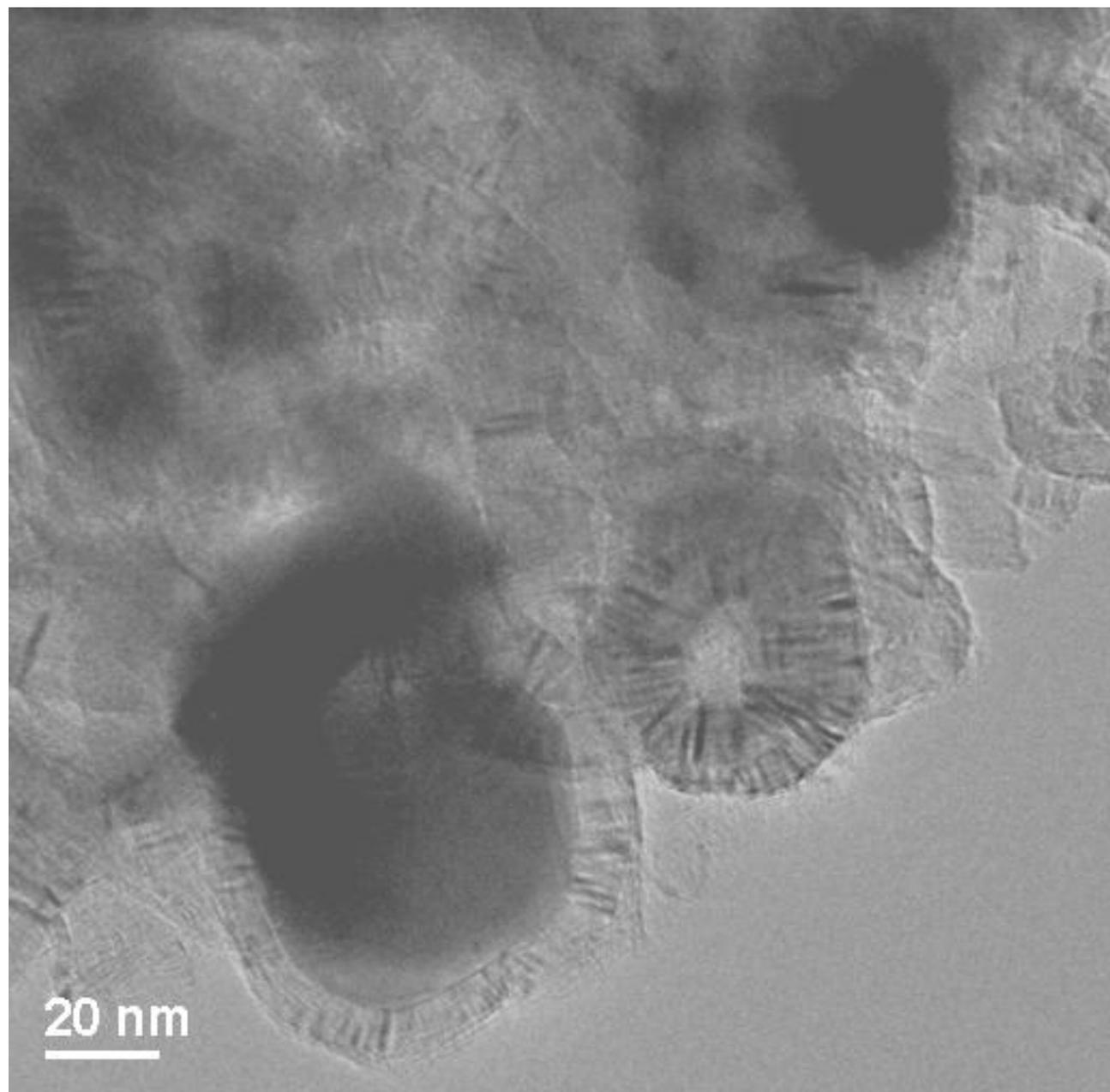
Post 800°C reaction TGA in 2%O₂/Ar

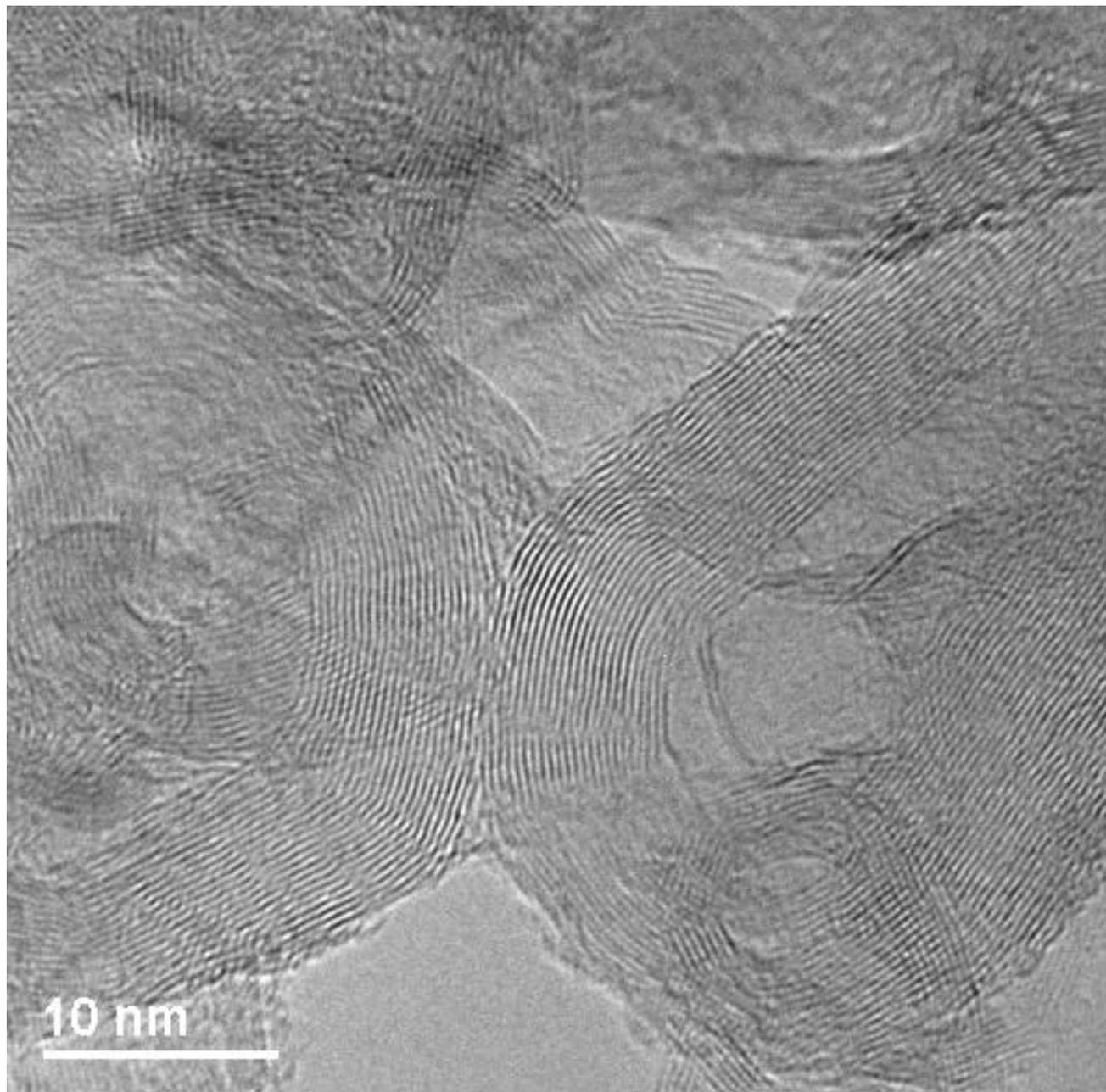


RM4 47.71 wt%C, RM6 43.49wt %C & RM7 38.06wt%C

SEM of post *in-situ* XRD RM 7 - 72wt%C







Butane cracking



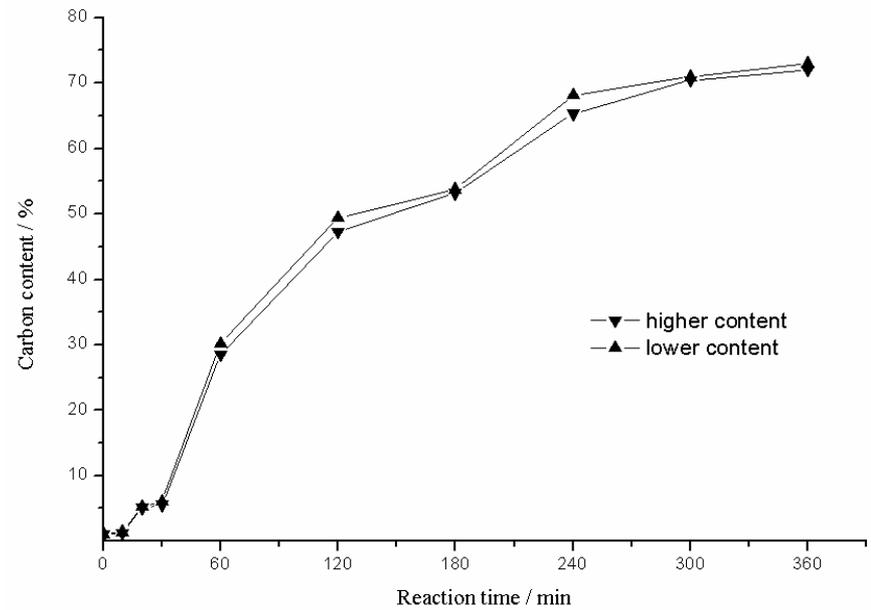
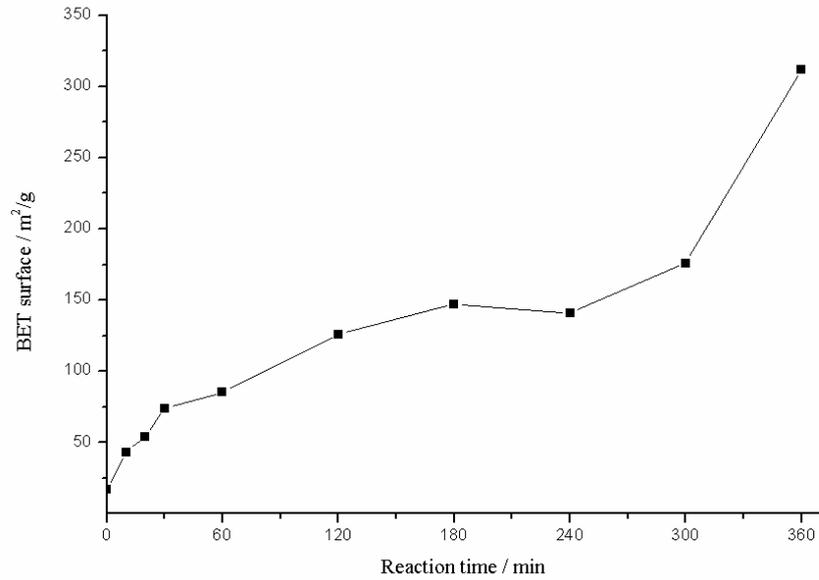
Adsorption capacity of Cr, Cu and Pb on RM, ARM and CRM

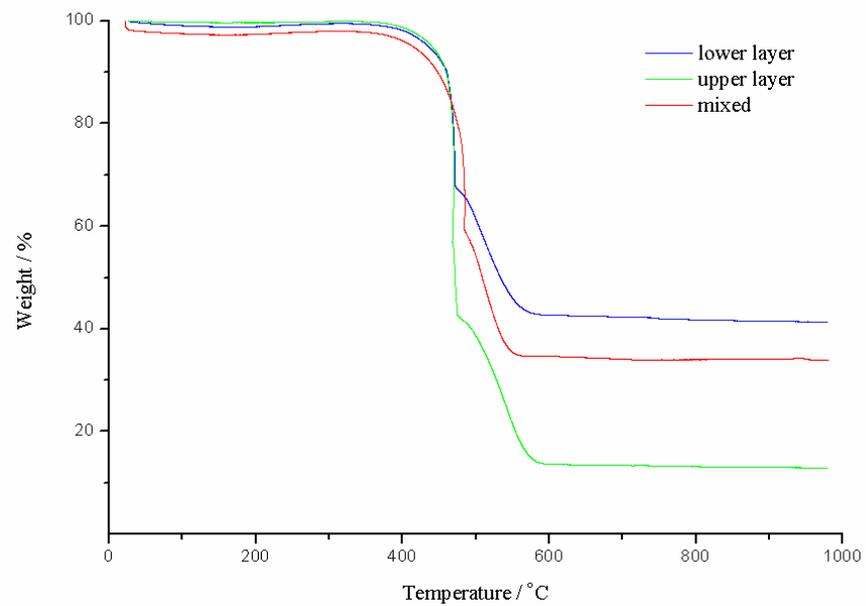
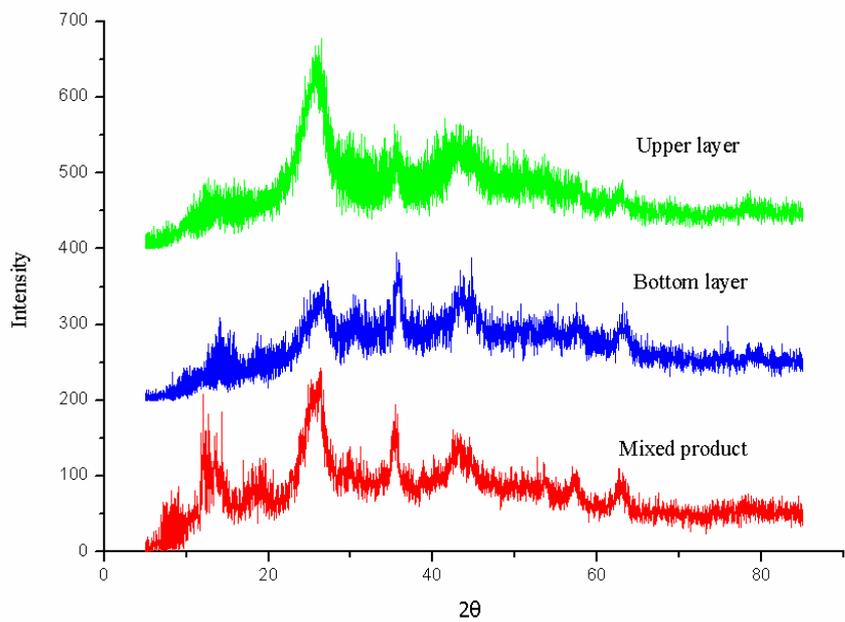
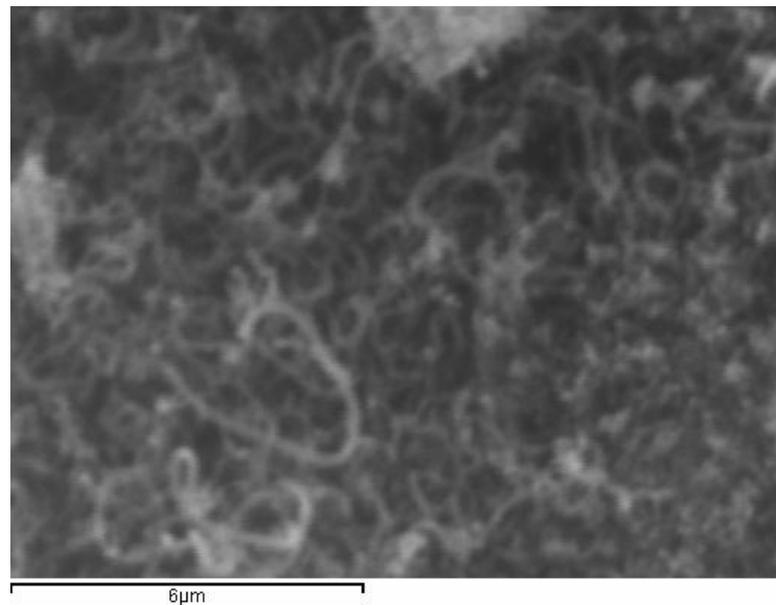
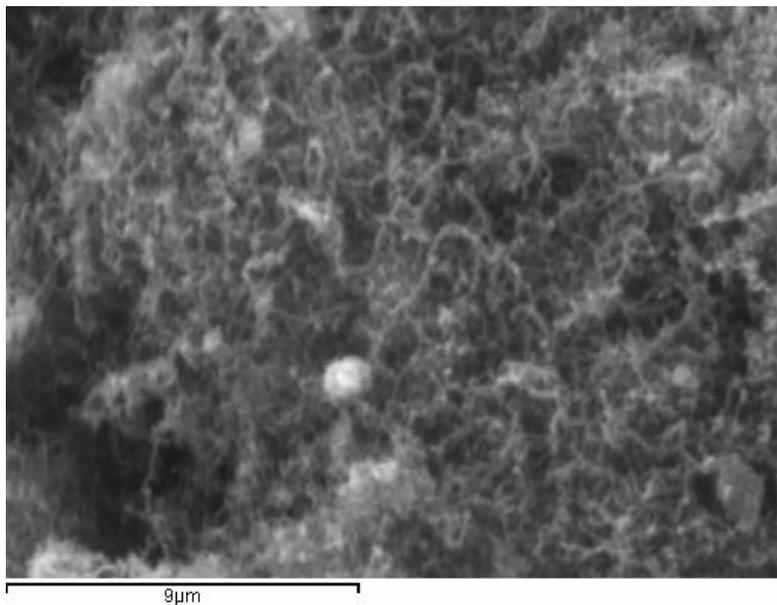
	pH	Surface area m ² /g	Cr		Cu		Pb	
			mg/g	mmol/g	mg/g	mmol/g	mg/g	mmol/g
RM	11.5	10-15	1.3	0.025	8.9	0.14	133	0.64
ARM	4.5	45-48	1.7	0.033	3.5	0.055	9.0	0.045
CRM	8.2	70	0	0	25	0.39	94	0.45

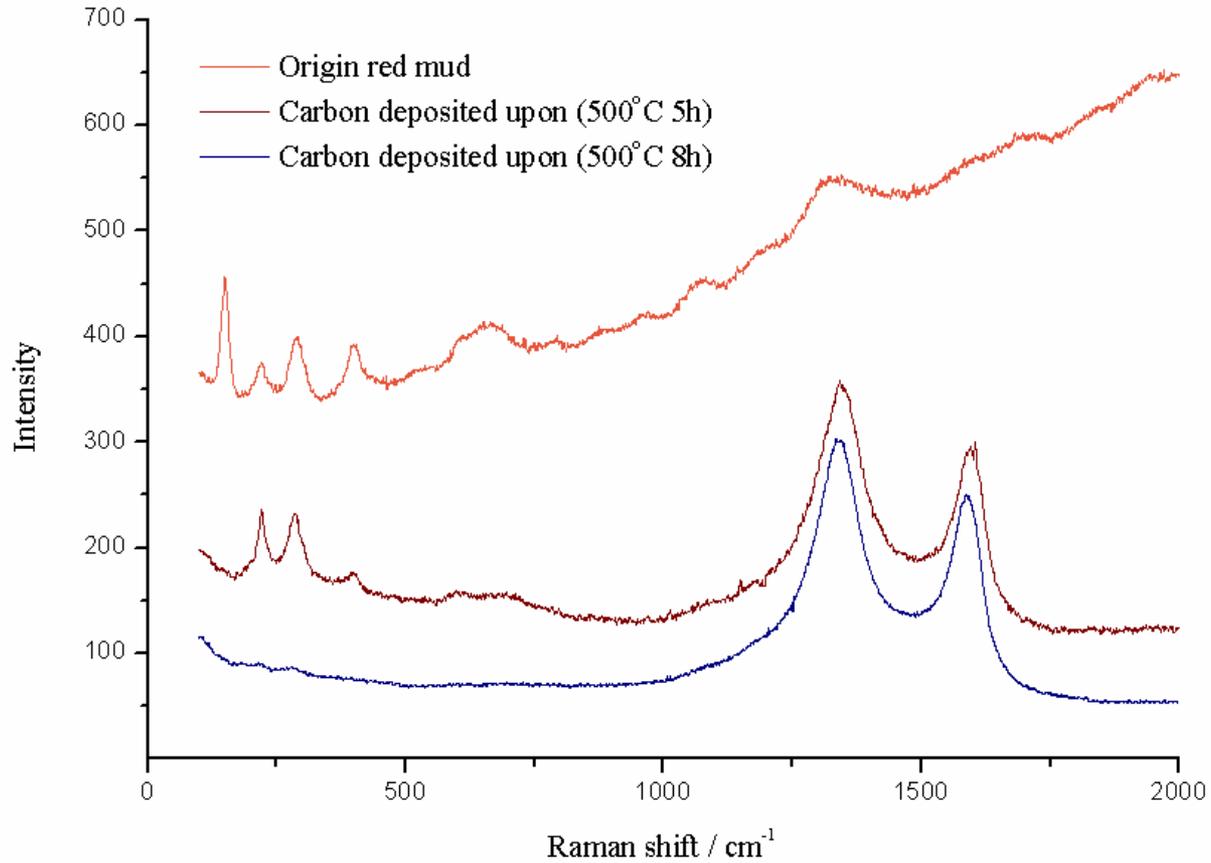
CrO₄²⁻, Cu²⁺ & Pb²⁺



Methanol – CH₃OH

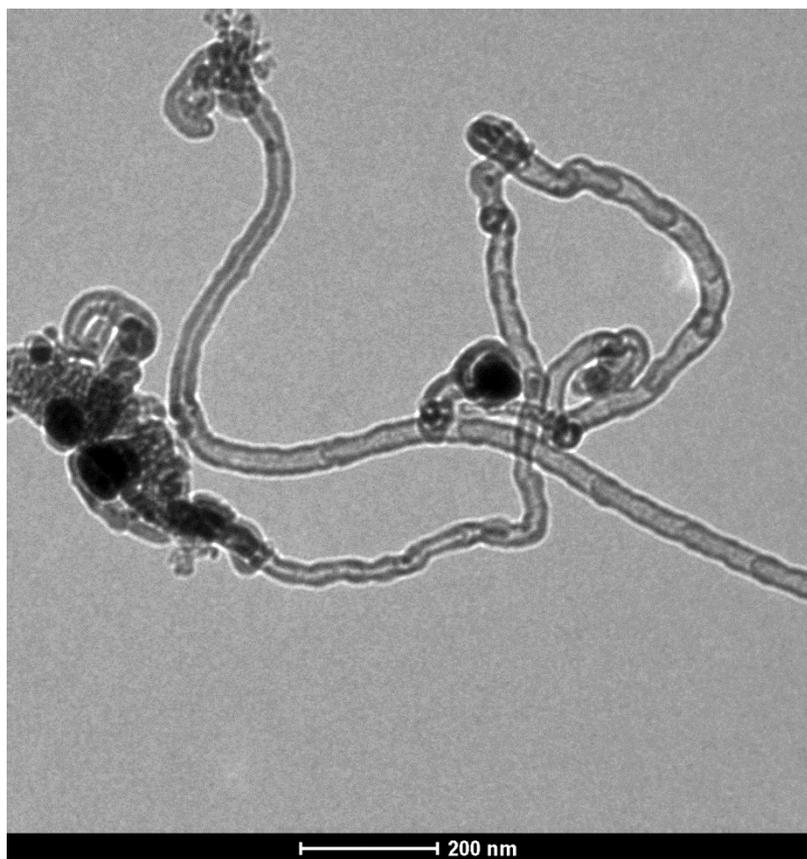




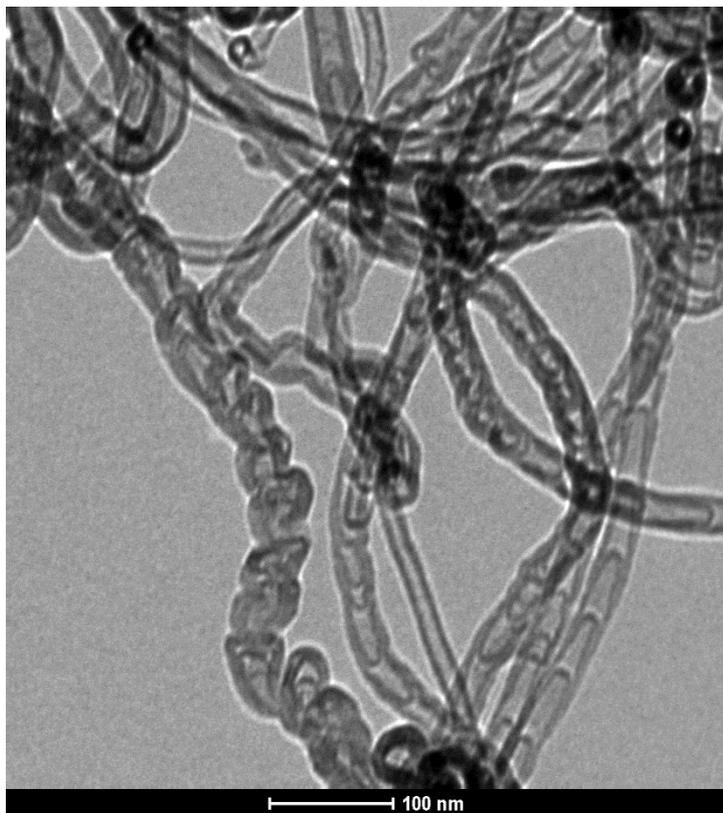


Acetonitrile – CH_3CN

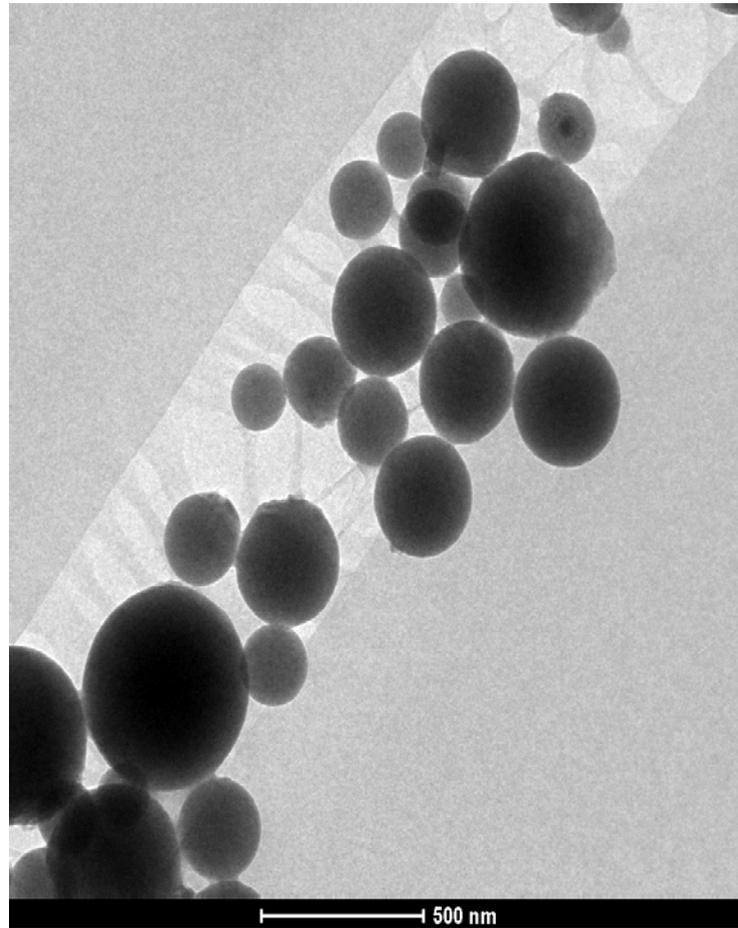
700°C



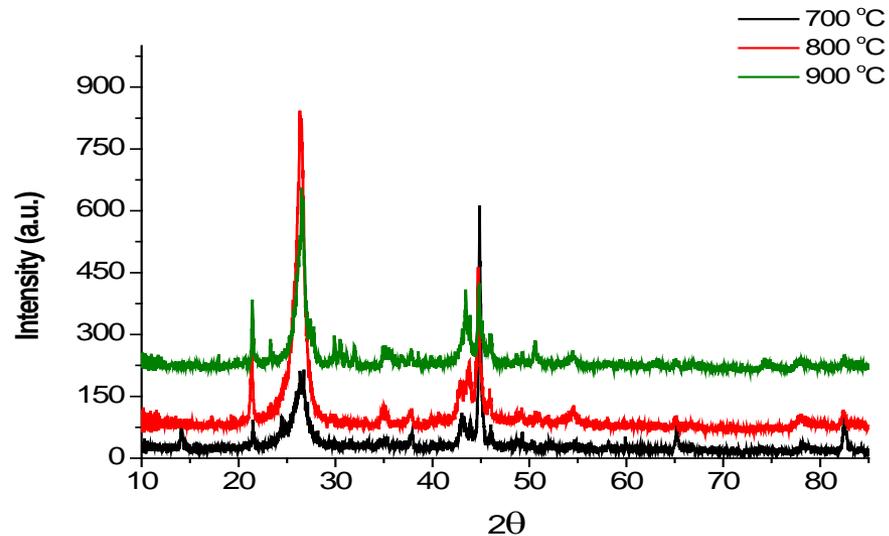
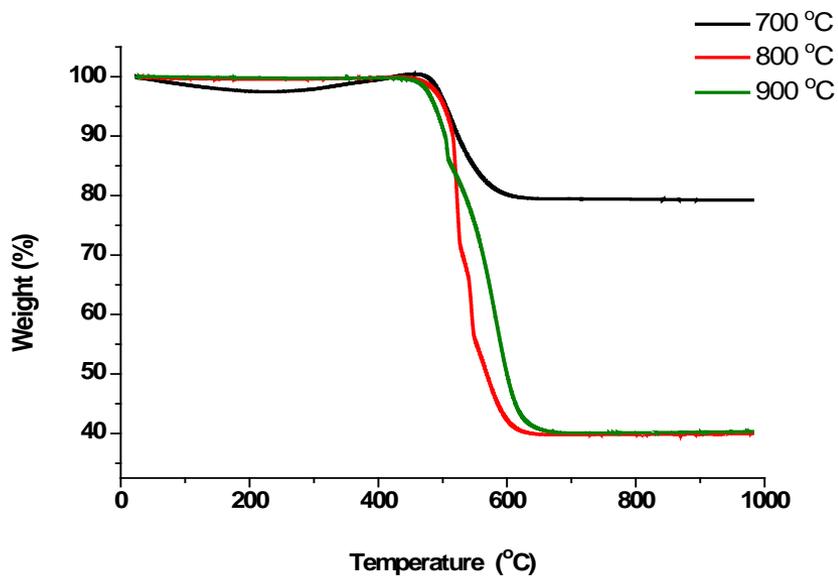
800°C

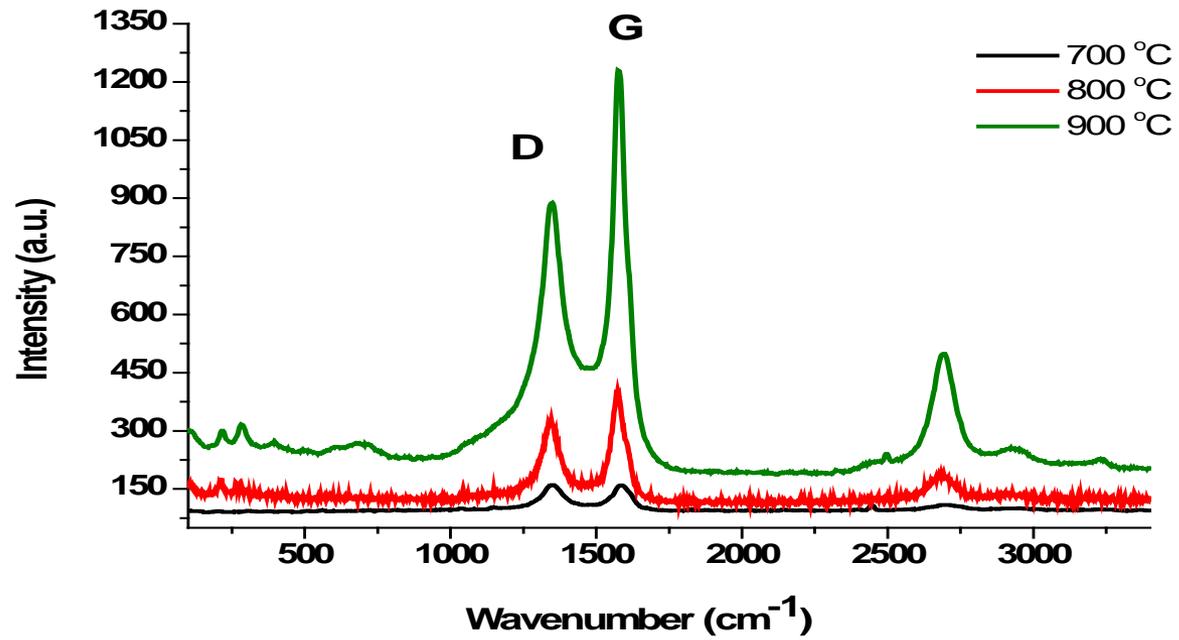


900°C



	C (wt%)	H (wt%)	N (wt%)
700°C	22.35 ± 4.77	-	1.31 ± 0.21
800°C	61.40 ± 7.10	-	1.70 ± 0.25
900°C	63.10 ± 0.52	-	1.60 ± 0.16







	Temp. (°C)	C(wt%)	H(wt&%)	N(wt%)
Ni/ZSM-5	700	10.56 ± 0.12	0.46 ± 0.01	0.95 ± 0.02
Pd/ZSM-5	700	10.22 ± 0.01	0.43 ± 0.01	0.91 ± 0.01
RM7	700	17.50 ± 9.10	-	-
Ni/ZSM-5	800	16.24 ± 0.74	-	1.41 ± 0.03
Pd/ZSM-5	800	16.00 ± 0.10	0.21 ± 0.04	1.25 ± 0.01
RM7	800	43.54 ± 7.53	-	-
Ni/ZSM-5	900	44.82 ± 0.01	3.02 ± 0.06	-
Pd/ZSM-5	900	35.60 ± 0.10	-	2.16 ± 0.01
RM7	900	48.42 ± 0.71	-	0.57±0.21

RM – C is very heterogeneous

Summary:

The efficacy of a variety of red muds for the production of hydrogen and graphitic carbons has been demonstrated.

Different carbon structures containing different degrees of functionality can be prepared.

The presence of reduced iron phases in post reaction samples imparts magnetic behaviour which may facilitate envisaged downstream applications.

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