

ULTRA-FAST MICROWAVE PROCESSING OF MATERIALS

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Energy efficiency, sustainability and economic viability have become increasingly important in the materials manufacturing sector. Conventional synthesis of solids is time- and energy-intensive, often requiring high temperatures and complex procedures. Microwave (MW) methods are a viable alternative while providing the opportunity to access new and metastable materials and to understand the interaction of solids with electromagnetic fields [1].

Carbon-containing materials are attractive candidates for MW synthesis on account of the high dielectric loss tangent exhibited by C at MW frequencies, resulting in rapid temperature increases during MW heating. Reaction times can be orders of magnitude shorter than seen conventionally. As potential products of such reactions, carbides possess high melting points, hardness, fracture toughness, compressive strength and chemical resistance, finding application as cutting tools and ceramics. Recently carbides have also found uses in catalysis. We will describe the synthesis of WC, Mo₂C, SiC and ternary carbides using both multimode and single mode MW systems and demonstrate how synthetic and reactor parameters can be exploited to control microstructure.

Ex-situ analysis allows characterization of the materials formed, but gives little insight into reaction mechanisms. There are no examples of in-situ studies of MW synthesis in the solid state. Thus, we are developing bespoke MW reactors for use at the ISIS and ILL neutron sources to enable us to study solid state synthesis reactions in-situ via time-resolved neutron powder diffraction. We will present details of the development of our reactors.

References

[1] H. J. Kitchen, S. R. Vallance, J. L. Kennedy, N. Tapia-Ruiz, L. Carassiti, A. Harrison, A. G. Whittaker, T. D. Drysdale, S. W. Kingman, and D. H. Gregory, *Chem. Rev.*, **114** (2014) 1170.

□Profile□

Prof. Duncan H. Gregory FIoN FIMMM FRSC□

Present Appointment

Head of Inorganic Chemistry and WestCHEM Chair of Inorganic Materials, WestCHEM, Dept. of Chemistry, University of Glasgow (April 2006).

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Previous Appointments

2005-2006	Reader in Materials Chemistry, School of Chemistry, University of Nottingham.
2002-2005	Lecturer in Materials Chemistry, School of Chemistry, University of Nottingham.
1997-2002	EPSRC Advanced Fellow, School of Chemistry, University of Nottingham.
2010	Visiting Professor, Université de Rennes 1, France.
2012-2015	Visiting Professor, Zhejiang University of Technology, China.
2015-	Visiting Professor, Kyushu University, Japan.

Education

1986-1993	University of Southampton, Highfield, Southampton SO9 5NH.
1989	BSc (Hons) in Chemistry with Physics.
1993	PhD in Solid State Chemistry (supervisor: Prof. M.T. Weller).

Honours and Distinctions

2009	Royal Society of Chemistry (RSC) Sustainable Energy Award.
1997	EPSRC Advanced Fellowship.

□Fellow of the RSC, Institute of Nanotechnology (FIoN) and of IOM3 (FIMMM).

□Member of the ACS and MRS and former Vice-President of the RSC Materials Chemistry Division.

□Editor in Chief of “Inorganics”, Associate Editor of “Materials for Renewable and Sustainable Energy”. Editorial Board of “Nanomaterials and Energy” and “Materials”; Editorial Advisory board for “Dalton Transactions”.