Synthesis of Advanced Polymeric Materials Using Supercritical Fluids

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Supercritical carbon dioxide has attracted much interest recently as an alternative solvent for the synthesis and processing of advanced materials [1]. Researchers have promoted CO_2 as a sustainable and 'green' solvent because it is nontoxic, nonflammable, and naturally abundant. In fact, the economics of using dense CO_2 on an industrial scale are usually complex and must be assessed on a case-by-case basis. Issues such as capital costs associated with high–pressure equipment and the energy requirements for compressing CO_2 into the dense state may prove prohibitive in many instances. Nevertheless, it is widely accepted that the advantages associated with this solvent are likely to lead to a number of new CO_2-based processes. The level of interest in supercritical fluid technology can be gauged from the growing number of participating academic and industrial research groups worldwide.

In Liverpool, we are developing new methods for the preparation of advanced organic and inorganic materials using supercritical carbon dioxide as a solvent [2]. This lecture will describe how CO_2 can be used as a solvent for the synthesis of a range of materials including cross-linked polymer microspheres [3,4], porous polymer monoliths [5,6], macroporous polymer beads [7], and emulsion-templated materials [8]. The use of other fluids (*e.g.*, R134a) for dispersion polymerization at much lower operating pressures (<20 bar) will also be described [9].

We will show how material properties can be 'tuned' by varying the supercritical fluid solvent density and will discuss the benefits and drawbacks associated with the use of SCF solvents in each case [10].

[1] (a) A. I. Cooper, *Adv. Mater.* **2001**, *13*, 1111; (b) A. I. Cooper, *J. Mater. Chem.*, **2000**, *10*, 207 (and references therein)
[2] More details can be found on our web-site: http://www.liv.ac.uk/~aicooper/cooper.htm
[3] A. I. Cooper, W. P. Hems, A. B. Holmes, *Macromol. Rapid Commun.*, **1998**, *19*, 353.
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[5] A. I. Cooper, A. B. Holmes, *Adv. Mater.* **1999**, *11*, 1270.
[6] A. I. Cooper, C. D. Wood, A. B. Holmes, *Ind. Eng. Chem. Res.* **2000**, *39*, 4741.
[7] C. D. Wood, A. I. Cooper, *Macromolecules* **2001**, *34*, 5.
[8] (a) R. Butler, C. M. Davies, A. I. Cooper, *Adv. Mater.*, **2001**, *13*, 1459; (b) A. I. Cooper, *Materials World*, Jan **2002**, 24.
[9] C. D. Wood, C. Martin, J. Cuellar, A. I. Cooper, *Macromolecules*, **2002**, *in press*.
[10] We are grateful to EPSRC (GR/23653, GR/R15597, GR/N39999, GR/R26252), the ACS Petroleum Research Fund (35363-AC7), the University of Liverpool, Bradford Particle Design Plc, and Avecia Ltd. for generously supporting this research. AIC thanks the Royal Society for provision of a *University Research Fellowship*.