Polymer Synthesis, Polymer Processing and Medical Devices: A Supercritical Approach

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Supercritical fluids have a unique combination of gas like and liquid like properties. This lecture will describe how we exploit these properties to synthesise new polymers and new materials for medical and pharmaceutical applications that could not be made using conventional solvents. One of the major attractions is that supercritical carbon dioxide ($scCO_2$) is inexpensive and provides an environmentally acceptable and cleaner alternative to the use of conventional organic solvents.

Polymer Synthesis: Most polymerisation studies in $scCO_2$ have focussed on free radical polymerisations. This presentation will describe some new approaches that have been explored at Nottingham including living radical (RAFT, ATRP) and ring opening polymerisation routes using enzyme catalysts to make valuable **block co-polymers.**

Polymer Processing: $scCO_2$ plasticises certain amorphous polymers, effectively liquefying them at close to ambient temperature to allow innovative processing. Under these conditions, it is possible to physically mix delicate protein based molecules such as growth factors or drugs within the liquefied polymer phase. Following depressurisation, drug loaded microporous foams or microparticles suitable for injection are generated. No solvent residues remain after processing and high protein loadings can be incorporated in a one-step process. Most importantly, because they are not exposed to either high temperatures or conventional organic solvents, the materials are clean, retain full activity and can be used for **tissue engineering** or **drug delivery applications**.

Recent Literature

- Kanczler J.M., Ginty P.J., Barry J.J.A., Nicholas M.P., Clarke M.P., Howdle S.M., Shakesheff K.M. and Oreffo R.O.C., The Effect of Mescenchymal Populations and Vascular Endothelial Growth Factor Delivered from Biodegradable Polymer Scaffolds on Bone Formation. *Biomaterials*, **2008**, 29, 1892-1900.
- Ginty, P. J.; Barry, J. J. A.; White, L. J.; Howdle, S., M.; Shakesheff, K. M., Controlling Protein Release from Scaffolds using Polymer Blends and Composites. E*uropean Journal of Pharmaceutics and Biopharmaceutics* **2008** 68, 82 - 89.
- Lee, H., Terry, E., Zong, M., Arrowsmith, N., Perrier, S., Thurecht, K.J., Howdle, S.M., Successful Dispersion Polymerization in Supercritical CO_2 Using Polyvinylalkylate Hydrocarbon Surfactants Synthesized and Anchored via RAFT. *J.Am.Chem.Soc*, **2008**, 130. 12242 – 12243
- Villarroya, S., Thurecht K.J., Heise A. and Howdle S.M., Supercritical CO_2: an effective medium for the chemo-enzymatic synthesis of block copolymers, *Chem. Commun.*, **2007**, 3805-3813.
- Jordan, F.; Naylor, A.; Kelly, C.; Howdle, S.M; Lewis, A.; Illum, L., Sustained release hGH microsphere formulation produced by a novel supercritical fluid technology: In vivo studies. *Journal of Controlled Release.* **2010** (In Press).