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ORIGINAL PAPER

Synthesis of a photoactive gemini surfactant and its use in AGET ATRP miniemulsion polymerisation and UV curing

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A novel photoactive gemini surfactant was easily synthesised in high yields. The multi-functional molecule can be used as a gemini surfactant, a benzophenone type photoinitiator, and as an ATRP initiator. Poly(methyl methacrylate) (PMMA) and poly(methyl methacrylate)-*block*-poly(allyl methacrylate) (PMMA-*b*-PAMA) were prepared using the photoactive gemini surfactant as an ATRP initiator under soap-free miniemulsion polymerisation conditions. Kinetic results of the miniemulsion polymerisation of methyl methacrylate (MMA) indicate that the reaction has controlled/living characteristics. UV curing was performed by irradiation of the linear PMMA-*b*-PAMA polymer, in which PMMA-*b*-PAMA containing a benzophenone moiety functioned as a macromolecular photoinitiator.

Keywords: gemini surfactant, photoinitiator, activator generated by electron transfer atom transfer radical polymerisation (AGET ATRP), miniemulsion polymerisation, soap-free

Introduction

Controlled/living radical polymerisation (L/CRP) has drawn great attention in recent years due to its significant academic value and promising industrial applications (Braunecker & Matyjaszewski, 2007; Chu et al., 2012; Zhang et al., 2009; Destarac, 2010). Many functional polymers and materials were prepared by this versatile technique, e.g. polymer brushes (Tsujii et al., 2006), telechelic polymers (Tasdelen et al., 2011), stimuli-responsive polymers (Yan et al., 2011), photoelectric functional molecules (Zhu et al., 2011; Shen et al., 2009), functional biomacromolecules (Benoit et al., 2011), etc. Among various L/CRP methods, atom transfer radical polymerisation (ATRP) and a recently developed activator generated by electron transfer for atom transfer radical polymerisation (AGET ATRP) are prominent due to their advantages such as easy manipulation, absence of conventional radical initiator, adaptability to most vinyl monomers and reaction systems, tolerance to many functional groups, etc. (Matyjaszewski, 2012; Jiang et al., 2012; Zhai et al., 2012; Lou & Shipp, 2012; Bai et al., 2011, 2012; Jakubowski & Matyjaszewski, 2005; Miao et al., 2012).

With the increasing global environmental protection pressure on chemical industries, people are seeking safer and environmentally friendly reagents as well as solvents or media to meet the demand of "green chemistry". The most preferable reaction medium is water which is safe, nontoxic, cheap, and eco-friendly (Lindström, 2007). For ATRP reactions in aqueous systems, the miniemulsion polymerisation approach is preferred; its controlled/living characteristics are best compared with those of emulsion polymerisation and microemulsion polymerisation methods (Mincheva et al., 2009; Oh et al., 2009; Cheng et al., 2011a). However, to stabilise the dispersion system in conventional emulsion polymerisation, small molecular emulsifiers are usually used, these are only physically ad-

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