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Rose Bengal based polymer colloids for photosensitized singlet oxygen production

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In the field of molecule oxidation, photochemical processes are of interest in order to fulfill some principles of green chemistry. Thus, only oxygen from air, light source in the low energy visible range and organic photosensitizer (PSens) are required to produce singlet oxygen, a powerful oxidant used for either fine chemistry reactions¹ or photodynamic inactivation of bacteria². Immobilization of PSens on solid substrates improves their handling, recyclability, stability and facilitates purification steps to remove the organic photocatalyst from the reactants in fine chemistry reactions. In this context, polymer colloids are versatile substrates for anchoring PSens. Stable submicronic polymer colloids can be directly synthesized by polymerization in dispersed media, either in aqueous continuous phase (emulsion, mini-emulsion or aqueous dispersion polymerization) or ethanolic continuous phase (dispersion polymerization), both continuous phases being associated with low chemical hazard. For instance, core-shell waterborne latexes were efficient to produce singlet oxygen in water using Rose Bengal (RB) based comonomer for anchoring RB PSens.^{4,5} The corresponding films prepared by simple casting proved to be active in interfacial production of singlet oxygen.^{4,5} Microgels synthesized by miniemulsion polymerization were inactive in water due to the collapse state of polymer core containing the PSens but the swollen microgels were active after redispersion in ethanol.³ Ethanolic continuous phase is of interest to implement photooxidation of hydrophobic organic molecules, including biobased molecules, exhibiting low solubility in water.

Consequently, synthesizing the photoactive polymer colloids directly in ethanol by dispersion polymerization would be valuable. Polymerization-induced self-assembly (PISA) involving in-situ block copolymer formation is suitable to design core-shell particles with the outer-shell functionalized by the PSens.^{4,5,6} PISA in alcoholic dispersion will be implemented in the present work to design novel photoactive polymer colloids. The commercially available Rose Bengal (RB) was selected as PSens due to its high photochemical efficiency. To covalently anchor the RB, we synthesized a polymerizable methacrylate monomer that can be copolymerized with a polar monomer to synthesize the solvophilic reactive block. The colloidal features of the block copolymer particles will be investigated according to the length of each block. Through the determination of the average quantum yield of singlet oxygen production (ϕ_{Δ}), we proved the efficient production of singlet oxygen at the particle/alcohol interface under visible light irradiation. The present study proposes to investigate whether the colloidal features or RB loadings would affect the value of ϕ_{Δ} .



Figure 1 – principle of photoactive polymer colloids synthesis

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