Ultrasonically Initiated Emulsion Copolymerization of Styrene and 2-Hydroxyethyl Methacrylate: Parameter Optimization


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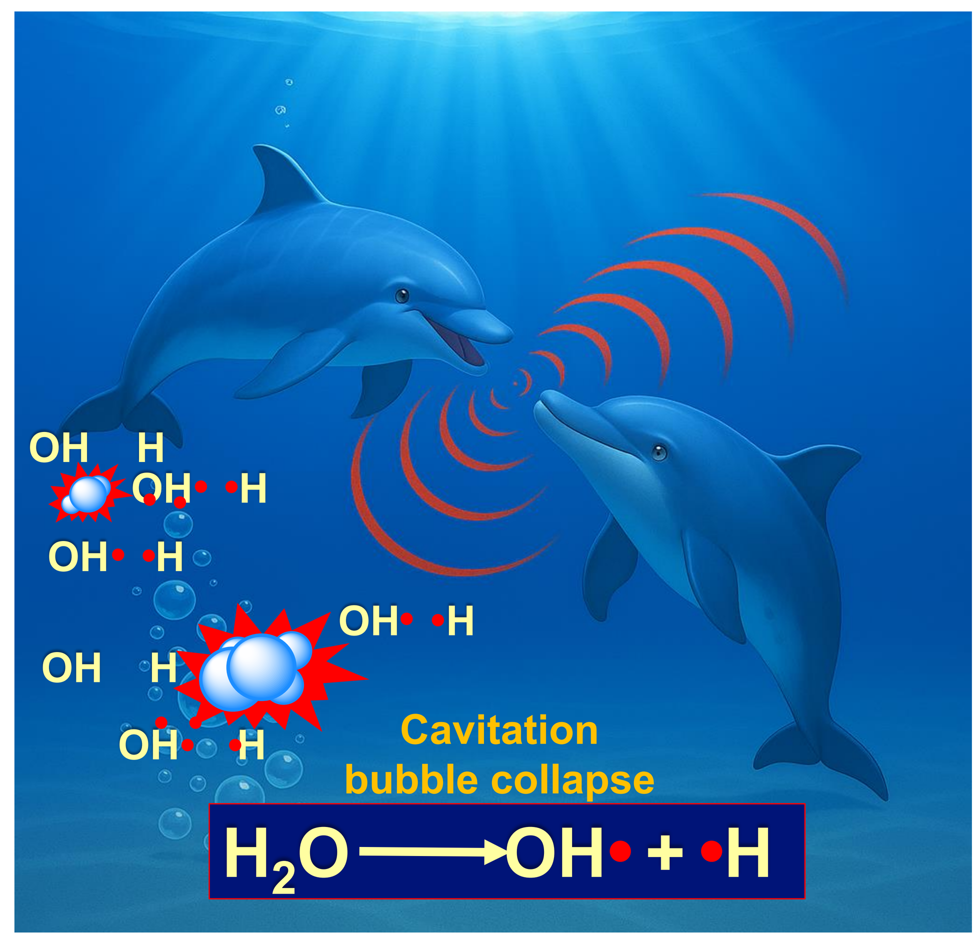
Introduction and Objective

In recent years, ultrasonic irradiation has emerged as a powerful tool for polymerization[1]. The initiation process of conventional emulsion polymerization is driven by free radicals generated thermal, photochemical, or a redox-induced dissociation of azo, peroxy, and persulfate compounds[2]. These methods entail certain drawbacks such as the need for elevated temperatures, safety concerns associated with radiation sources, and limited initiation in photochemical dissociation. Ultrasonic irradiation can replace chemical initiators in emulsion polymerization by generating radicals through the decomposition of solvent and solute molecules as a result of bubble collapse[3]. This method promises a sustainable and environmentally friendly approach and leads to synthesis of high-purity products[3]. The motivation of this study was to conduct a systematic investigation on the parameter optimization of ultrasound (US)-assisted emulsion copolymerization of styrene (St) and 2-hydroxyethyl methacrylate (HEMA) conducted without an exogenous chemical initiator.



Results and Discussion

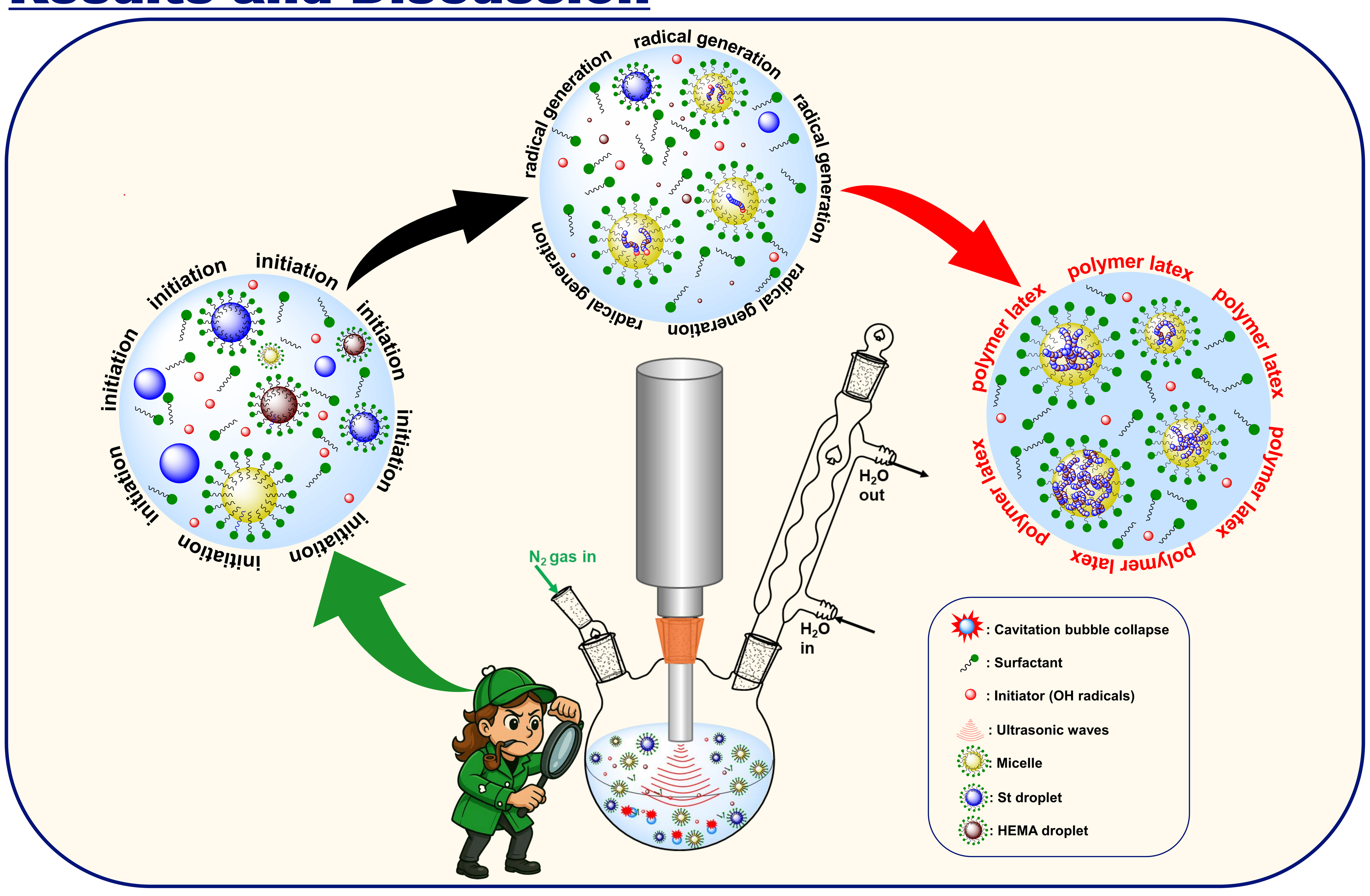


Figure 1. Schematic representation of the probable US-assisted emulsion copolymerization of St and HEMA without an exogenous chemical initiator.

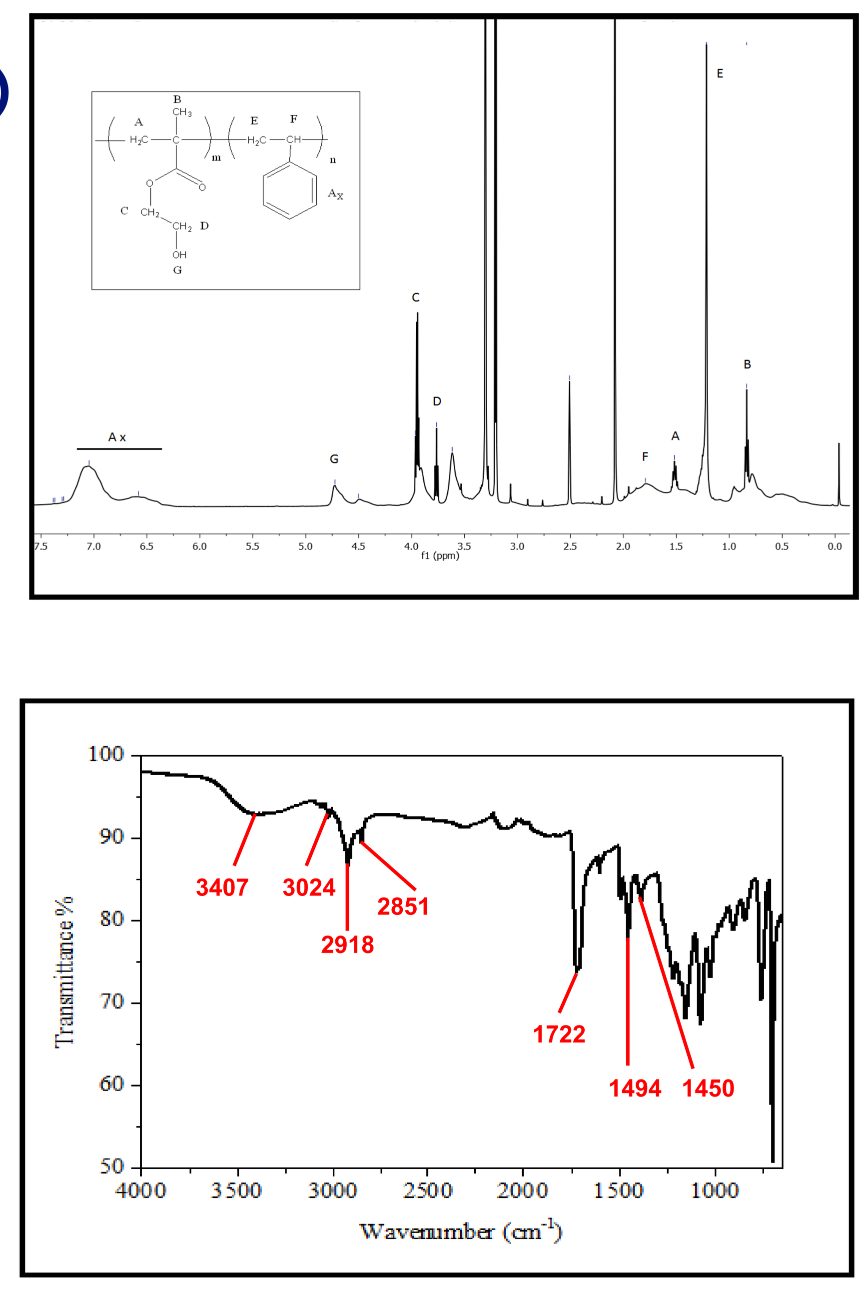


Figure 2. (a) ^{1}H-NMR **(b)** FT-IR spectra of Poly(St-co-HEMA)

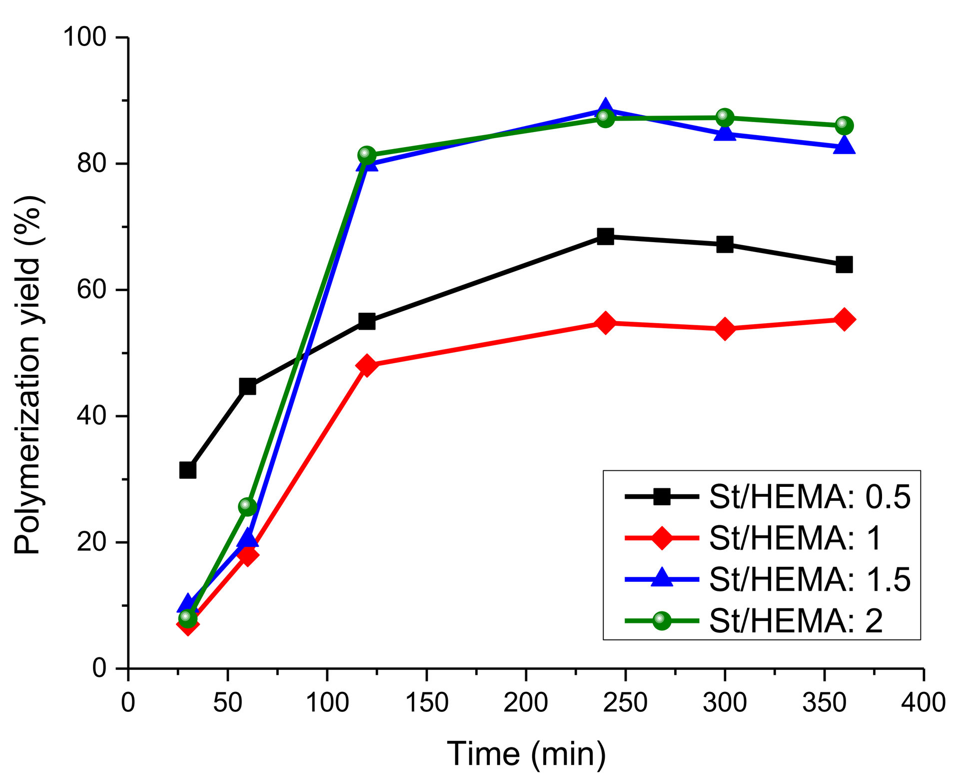


Figure 3. The effect of St/HEMA ratio on polymerization yield (M/W: 10% (w/w), SDS/M: 10% (w/w), US intensity: 34-37 W, reaction temperature: 50^{o}C)

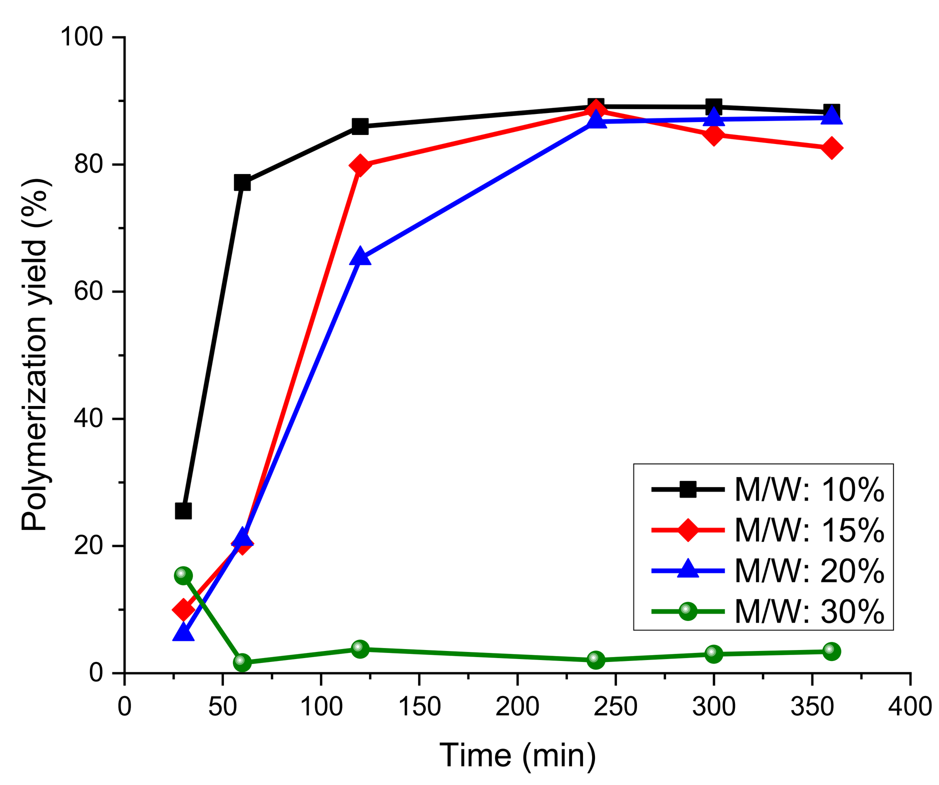


Figure 4. The effect of M/W ratio on polymerization yield (St/HEMA: 1.5, SDS/M: 10% (w/w), US intensity: 34-37 W, reaction temperature: 50^{o}C

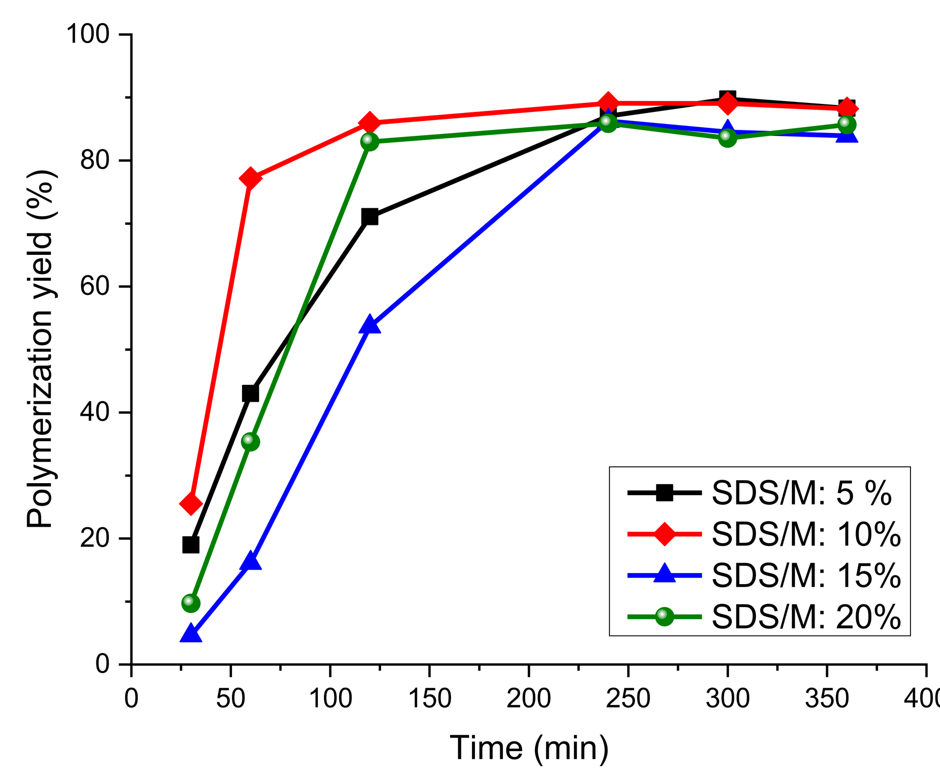


Figure 5. The effect of SDS/M ratio on polymerization yield (St/HEMA: 1.5, SDS/M: 10% (w/w), US intensity: 34-37 W, reaction temperature: 50^{o}C

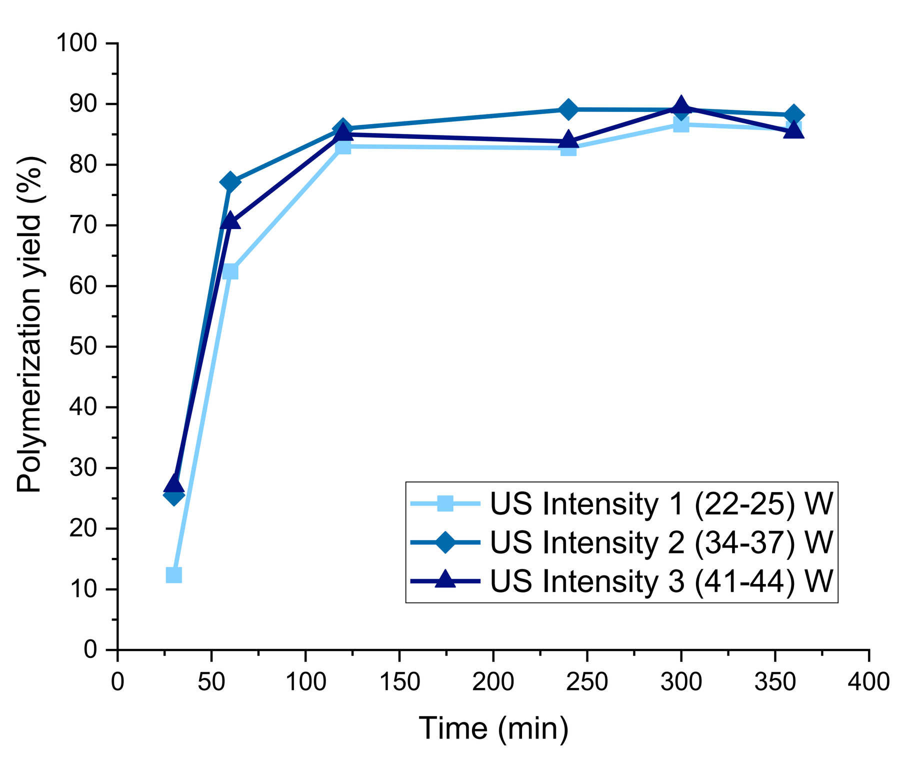


Figure 6. The impact of US irradiation intensity on polymerization yield (St/HEMA: 1.5, M/W: 10% (w/w), SDS/M: 10% (w/w), reaction temperature: 50^{o}C)

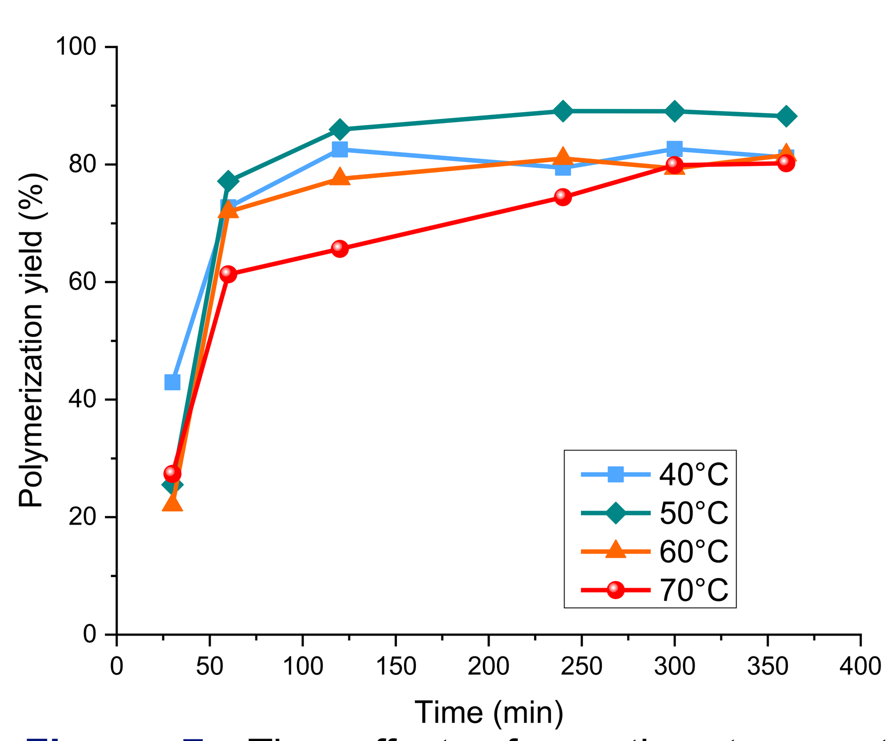


Figure 7. The effect of reaction temperature on polymerization yield (St/HEMA: 1.5, M/W: 10% (w/w), SDS/M: 10% (w/w), US intensity: 34-37 W)

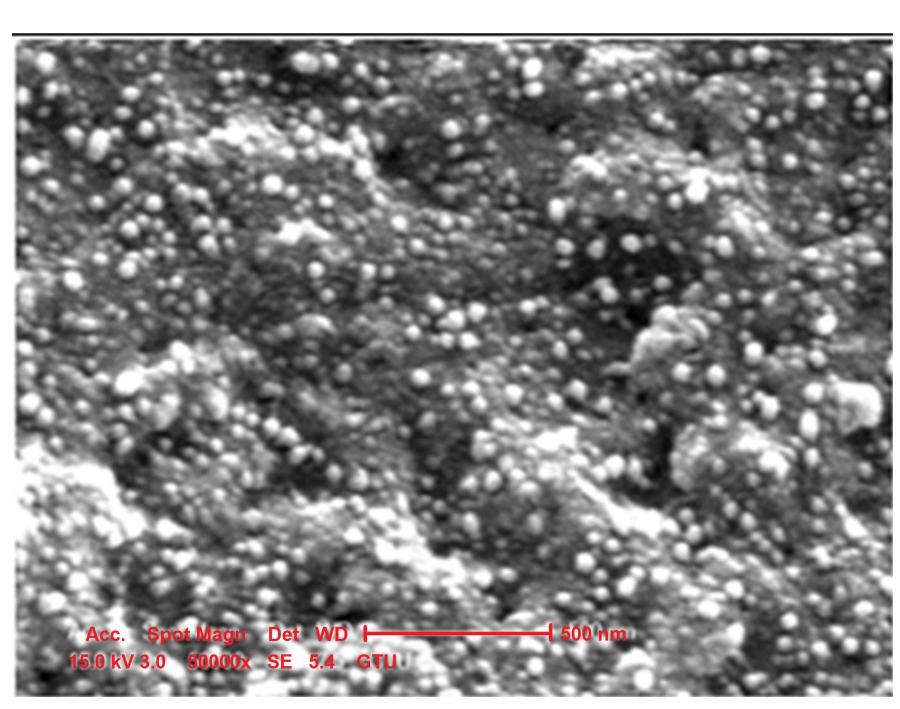


Figure 8. SEM image (x 50,000) of Poly(St-co-HEMA)

Acknowledgments

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Conclusions

- The maximum polymerization yield was ~89%
- The optimum conditions were St/HEMA molar: 1.5, M/W ratio: 10%, SDS/M ratio: 10%, US power: 34-37 W, and reaction temperature: 50^{o}C.
- The average diameter of spherical latex particles was measured as 80 nm.

References

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