Creating Monodisperse Particles Using Membrane Emulsification Technique for use in Environmental Sensing Applications

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This research is part of a larger effort to streamline EPA processes by creating an environmental sensor which will detect ultra-low-levels of α- and β-emitting radionuclides in water. This sensor will be filled with resin particles which contain ligands that bind to radionuclides present in the water, and fluorophores that scintillate upon the release of α- and β-emitting particles. For the design of the resin, we are aiming for a uniform diameter of 200-400 microns to aid in the modeling of the detector as well as to improve detection efficiency. To create uniform particles, membrane emulsification is being explored as a pre-treatment step to suspension polymerization. Composition of the organic and aqueous phase, membrane type, pore size, pitch, surfactant type, and stir speed have been tested to understand their role in creating stable emulsions. The droplets formed by membrane emulsification and reacted via suspension polymerization were analyzed by optical microscopy and processed with a program written in MATLAB. Preliminary results show that using a hydrophilic membrane with a pore size of 30 microns and a pitch of 200 microns, along with a stir speed of 430 rpm generate droplets with a coefficient of variation (CV) as low as 15. This CV is a significant improvement from polymerizing without a pre-treatment step, which results in a CV averaging 35. After producing uniform droplets by membrane emulsification, the next design challenge is to maintain droplet stability in the polymerization reactor. Our hypothesis is that the solubility of the monomers in the aqueous phase has an effect on the long term stability of the suspension. To test this, the type of salt and its concentration in the aqueous phase was varied and the resulting polymer particles were analyzed once again using MATLAB. CVs of 20 have been achieved thus far. The continued investigation of parameters affecting uniformity will result in lower CVs and an increasing amount of resin in our desired size range.