ENCAPSULATION OF AN AMINE USING MICROFLUIDICS

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ABSTRACT

The encapsulation of amines with traditional emulsification and interfacial polymerization techniques has been challenging due to their reactive nature and wide range of miscibility. In this study, we propose a new method where we encapsulate triethylenetetramine (TETA) within acrylate microcapsules using double emulsion templates made from microfluidics.
In this process, a 50 wt% solution of TETA in water is dripped from an emitting capillary into an acrylate monomer phase, which in turn is engulfed by another aqueous fluid and flow-focused into a collecting capillary, thereby forming double emulsions. The emulsions are collected downstream and irradiated with UV to form microcapsules via photopolymerization. The microfluidic approach allows for monodispersity in the size and properties of the capsules, which can be tuned through the fluid flow rates, capillary dimensions and monomer compositions.
To purify the amine, we exploit the extremely low volatility of TETA, which has a vapor pressure of only 0.01 mmHg at 20 °C. The capsules are washed with water and acetone and then dried in air. Thus, the water in the core is removed from the capsules through evaporation, leaving the amine inside.
The presence of TETA inside the capsules is confirmed with NMR spectroscopy. Despite the presence of some residual water, the amine is very reactive, which we verify by mixing and thereby curing epoxy with the contents of ruptured capsules. Current work is focused on combining amine and epoxy capsules to evaluate their performance in self-healing composites.