Characterization of the Mechanical Strength, Adhesion and Leakage of Microcapsules for Developing Consumer Products

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Microcapsules for consumer products should have desirable physicochemical, structural and mechanical properties, including size, shell thickness, permeability, mechanical strength and surface charge (1). One example is microcapsules containing liquid perfume used in detergents. The shell of the microcapsules should ideally be non-permeable, they should adhere to fabric surfaces in washing machine and can be broken by mechanical forces generated at end use, e.g. friction and rubbing between human body and fabric fibers. For such applications, it is crucial to optimize the mechanical strength of microcapsules in conjunction with reducing perfume leakage in detergents during storage and enhancing their adhesion on fabric surfaces.

A unique technique called micromanipulation has been applied to determine the mechanical properties of such microcapsules. This technique is based on compression of single micro-particles between two flat surfaces and simultaneous measurement of the force applied to them versus their displacement. From direct micromanipulation measurements, the force required to cause a given deformation of single microcapsules, diameter, visco-elastic-plastic behavior, rupture force and deformation at rupture can be obtained (2). Numerical modelling of the force versus displacement data with appropriate constitutive equations of the shell materials based on finite element analysis can be used to determine their intrinsic material property parameters, such as Young’s modulus, yield stress, plastic modulus, and stress/strain at rupture (3). The mechanical properties of microcapsules with a shell of melamine formaldehyde containing oil-based liquid perfume have been extensively investigated using the technique. Moreover, adhesion of single microcapsules on flat fabric surfaces was quantified by atomic force microscopy (4). The rate of perfume release from microcapsules to aqueous environment was measured based on an accelerated experiment by adding a water-soluble organic solvent to the aqueous environment, which can dramatically increase the solubility of perfume in the liquid (5). The data of the mechanical strength, adhesion on fabric surface, perfume leakage rate of microcapsules combined with their size, chemical composition, and structure can be used to optimize their formulation and processing conditions, leading to commercialization of perfume microcapsules in detergents. The details of these studies will be presented.

References: