Center for Particulate and Surfactant Systems (CPaSS)

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Targeted Removal of Stains by Cleaning Products

Surfactants, builders, binders, bleaching agents, and enzymes are different classes of compounds used in detergent systems. Differences are due to their physicochemical properties. Surfactants are versatile because their chemical structures consist of a hydrophobic (water-repelling) component and a hydrophilic (water-attracting) component. These allow them to interact with various chemicals in their surroundings. Surfactants also help to wet the skin and substrates. They facilitate soil removal and dissolution. In addition to surfactants, there are various other agents such as modified polymers and green surface active additives that aid in the removal of stains.

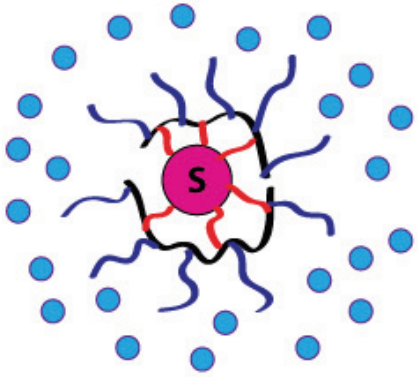
Factors that affect the washing performance of laundry detergents include the nature of the stains, soap structure and concentration, and the nature of active ingredients in soaps, water hardness, pH, and temperature. Some intricate stains result from personal care products such as deodorants which consist of various oils and metallic ions. Because of their complexity deodorants are not readily removed from fabrics by conventional methods. For such multifaceted stains, it is challenging to find the right balance of hydrophobic and hydrophilic constituents in cleaning formulations to achieve complete removal. The general objective of the research on cleaning products at CPaSS is to enhance stain removal by developing reagents targeted to destroy not only stains, smudges and dirt, but to elucidate the mechanisms by which stains are removed.

Systems that CPaSS researchers investigate for optimal stain removal performance include surfactants, polymers, hydrophobically modified polymers, and enzymes explored. Incorporation of the stains into microdomains of surfactant supramolecular structures is an effective way to solubilize the normally insoluble substances. Researchers have learned that the performance of surfactants and their synergistic/antagonistic interactions with other components in detergent systems definitely impacts the effectiveness of stain removal.

Recent work at CPaSS has focused on developing correlations between the chemical structure and properties of reagents and their performance. During this process, researchers have developed mixed surfactant systems and hydrophobically modified polymers that form stable aggregates capable of effectively removing and solubilizing both oily and particulate stains. In addition, they also found synergistic interactions between a group of nonionic (no electric charge) surfactants and detergent enzymes by investigating enzyme functionality and dynamics using experimental methods and computer model simulations. This combined with investigations of green surfactant alternatives to existing chemical formulations are useful for optimizing environmental sustainability.

This research has many important applications ranging from consumer home care and personal care products to industrial applications. Since surfactants, polymers, and enzymes are used widely in industry, this research impacts the consumer product sectors of home laundry and surface cleaning and personal skin and hair care. The work also impacts the industrial and business sanitization (restaurants, hotels, schools, airports and hospitals) and the mineral and petroleum extraction sectors. Depending on the sector needs, CPaSS research helps identify ingredients to use and how they should be formulated in order to develop and manufacture more effective cleaning products.

By 2017, the global sales of household cleaning products are predicted to reach $147 billion. All have significant positive economic impacts. Enhancing efficiency by increasing cleaning products' performance while lowering the necessary dosage of cleaning actives by using improved reagents and formulations of cleaning agents, will reduce production costs for industry and make them the products more affordable for consumers. More efficient formulations will allow lower water and energy usage. The amounts of chemical discharge into waste water will be decreased. This will bring about environmental benefits. Hence, the knowledge gained from this CPaSS research on enhancing formulations of existing cleaning products will bring about multifaceted economic benefits to the economy, improved sustainability, and higher consumer satisfaction.



Solubilization of stain molecule (represented in the left figure as a pink circle with letter "S") inside a surfactant aggregate. Surfactants have both hydrophilic groups (represented in red) and hydrophobic groups (represented in blue). These allows them to isolate and solubilize stains as they are washed away by water (represented as light blue circles).

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