RECENT DEVELOPMENTS IN MICROENCAPSULATION OF SELF-HEALING AGENTS

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ABSTRACT

Microcapsules represent reservoirs of healing agents that are dispersed into materials. Matrixes such as thermoset materials undergo damages over time due to external forces such as cyclic stresses and climate conditions. This can eventually lead to the formation of cracks, thereby deteriorating and weakening the materials. Upon crack formation, the microcapsules present in the matrix should break (and not debond) and release their reactive liquid content, allowing the material to recover its strength [1]. The development of self-healing materials has gained considerable attention over the last decade. This is driven by the replacement of heavy materials by lightweight high performance materials. The application fields include building and construction, automotive and aerospace, industrial applications, wind energy and marine applications.

Our research aims at the encapsulation of newly developed self-healing agents. Different synthetic routes for the formation of core-shell structures, well known in literature, are applied and adapted to our targeted systems. Emulsification of the active agent into an immiscible phase is realized upon mechanical stirring and shell formation is typically performed by interfacial polymerization of two monomers present separately in one of the liquid phase, or by dispersion polycondensation of a precondensate onto the droplet surface.

In self-healing composites, for capsules to rupture in a reliable fashion, they must have an effective embedded modulus lower than that of the surrounding polymer matrix. Typical compositions used for the shell material are poly(urea-formaldehyde) (PUF), poly(melamine-formaldehyde) (PMF), poly(melamine-urea-formaldehyde) (PMUF), polyurethane (PU) and acrylates.

This study not only demonstrates the interdependency of many parameters controlling the encapsulation process such as pH, temperature, ionic strength, stirring speed, and in general the concentration of each component but also discusses the complexity of having a reactive core system, such as multi-thiols. Moreover, new encapsulation strategies for the encapsulation of reactive ingredients, beyond the classical approaches, will be discussed.

REFERENCES

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