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Synthesis of Microcapsules Containing Polyaspartic Acid Ester within UV Curable Shell

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In recent years corrosion-resistant self-healing coatings have witnessed strong growth, and their successful laboratory design and synthesis categorises them in the family of smart/multi-functional materials. Among various approaches for achieving self-healing, microcapsule embedment through the material matrix is the main one for self-healing ability in coatings [1].

Polyaspartic coatings are based on aliphatic polyisocyanates and polyaspartic acid esters (PAAE). Reaction between those two components is extremely fast. The main advantages of polyaspartic coatings are high durability, fast return to service, UV stability, abrasion and chemical resistance. Due to high reactivity, polyisocyanates and PAAE have high potential in development of self-healing coatings. To create *two capsule* self-healing system, it is necessary to encapsulate separately both polyisocyanates and PAAE. Encapsulation of polyisocyanates like isophorone diisocyanate (IPDI) does not make any serious difficulties [2, 3]. Encapsulation of amines including PAAE is much more complicated and usually gives unsatisfactory results.

New method of encapsulation of PAAE *Desmophen NH 1220* was developed based on the use of UV-curable polyurethane acrylate resin as a shell material. 3D printing resin from *Anycubic* containing polyurethane acrylate resin, acrylate monomer and photoinitiator was used as a shell material. Formation of the microcapsules' shells was realized under UV irradiation and was very fast. Characteristics of the microcapsules were monitored by optical microscopy, scanning electron microscopy, FT-IR spectroscopy, and thermogravimetric analysis. Characteristics of the microcapsules were varied by changing processing parameters such as stirring rate, emulsifier type and concentration, and core to shell ratio. The process parameters were optimized using Taguchi experimental design method.

Changing reaction conditions and the ratio of PAAE to the solvents xylene, ethyl lactate or dichloromethane, stable microcapsules of PAAE were synthesized. The maximal amount of the encapsulated healing material PAAE was up to 64 %. Size of the microcapsules was varying in the range between 10 and 230 μm, and was controllable by the reaction conditions. Most of the microcapsules remained stable after lyophilisation and separation in powder form. Using Taguchi criteria "nominal is the better" for the microcapsule size of 50 μm, and criteria "larger is the better" for the amount of the encapsulated material, optimal conditions for encapsulation of PAAE were developed. Desirable microcapsules containing encapsulated PAAE were obtained at core to shell ratio 3:1, stirring rate 500 rpm, and a mixture of polyvinyl alcohol (1 %) and gum arabic (1.5 %) as an emulsifier.

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