MICROENCAPSULATION OF SELF HEALING AGENTS FOR CORROSION CONTROL COATINGS

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ABSTRACT

The detrimental effects of metallic corrosion are well-known in today's industrial society. Protective coatings are widely used to protect metallic structures from corrosion but their performance can be compromised by mechanical damage, such as a scratch, that exposes the metallic substrate. The incorporation of a self healing mechanism into a corrosion protective coating could significantly increase its effectiveness and extend its service life. This presentation reports the results obtained from the synthesis and evaluation of a number of candidate microcapsule-based self healing systems when incorporated into selected corrosion protective coatings.

One of the important factors that influence the healing efficiency of microcapsule-based self healing systems is the ability of the microcapsule to deliver its core content to the location where and when it is needed. This ability can be affected by the size of the microcapsule and surface energy between the healing agent, the coating matrix, and the metal substrate. Reducing microcapsule size can result in lower healing efficiency due to the reduced amount of healing agent as well as the difficulty to deliver healing agents. Another important factor is the ability of the microcapsule wall to keep the healing agent in the core until the microcapsule is broken.

Both *in-situ* polymerization and interfacial polymerization processes were developed to encapsulate self healing agents (Figure 1). Melamine formaldehyde pre-polymers and urea formaldehyde have been used as wall forming materials. Some cross-linking agents, such as pentaerythritol tetrakis(3-mercaptopropionate) (PTT), have proven useful to improve the mechanical strength as well as solvent resistance of the capsule walls. Initial evaluations of three candidate self healing systems, which included a two-capsule resin condensation system and a solvent carrier systems, were performed. Initial evaluations of these systems on steel substrates were carried out using ASTM B117 salt fog test.[1] This testing was done using a two-part epoxy coating with a thickness of approximately 250 to 400 microns. In order to evaluate the healing efficiency of each self healing system, three parallel scribes of different widths were made on each coated panel. The best healing efficiency was observed in the two capsule siloxane healing system. Some siloxane systems exhibited excellent corrosion protection when compared to control (as shown in Figure 2).

Among the evaluated systems, siloxane resins have proven to be the most difficult materials to encapsulate. The preparation of siloxane-filled capsules with average sizes between 10 and 20 microns, for use in thinner films of 50 to 75 microns in thickness, has been accomplished and these capsules were evaluated in a 75 micron coating. SEM observation and salt fog testing results of these small capsules showed that further optimization is needed to improve the viability of this set of capsules as self healing agents to prevent leakage of the self healing agent during microcapsule processing.

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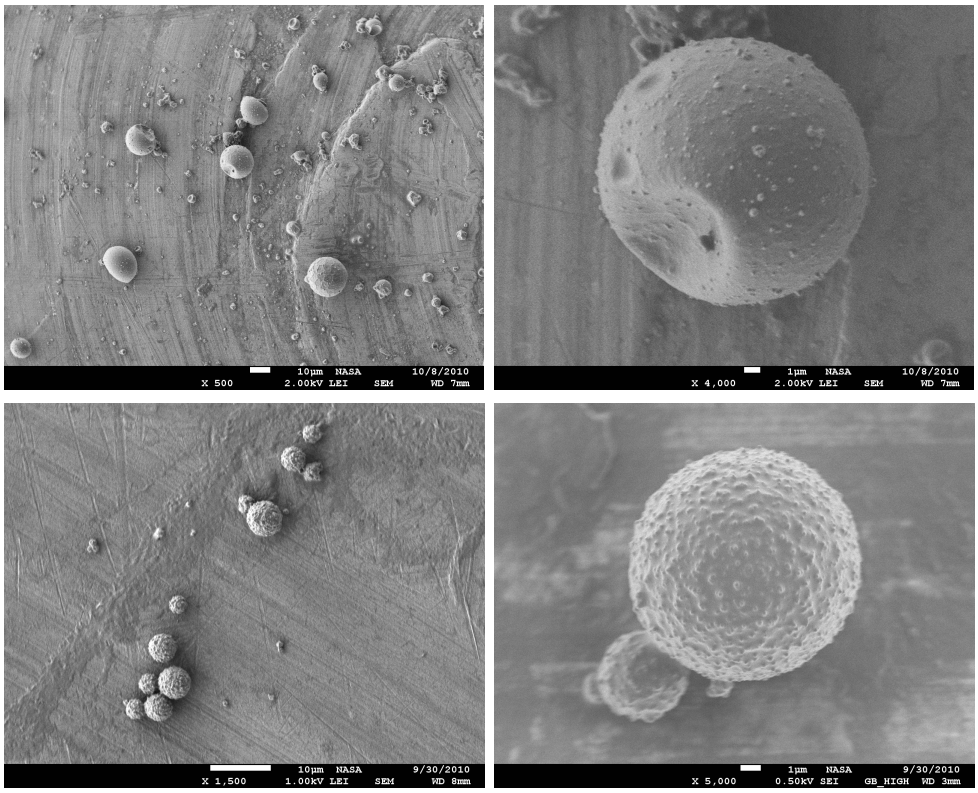

Figure 1. SEM images of microcapsules containing siloxane healing agents. These microcapsules were synthesized by interfacial polymerization (top) and *in situ* polymerization (bottom).

Figure 2. 700 hours of salt fog testing results of carbon steel panels coated with a control coating system (left panel) and the same coating with a siloxane healing system (right panel).

REFERENCES

[1] ASTM, *Standard Practice for Operating Salt Spray (Fog) Apparatus*, November, 1997.