EXPERIMENTAL INVESTIGATION OF THE SELF HEALING PERFORMANCE OF CFRP COMPOSITES SUBJECTED TO HIGH VELOCITY IMPACT

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ABSTRACT

The work is aimed at investigating the performance of self healing of composite parts subjected to very high velocity impact conditions prevailing in the space environment due to the presence of space debris. Microcapsules containing 5-Ethylidene-2-Norbornene (5E2N) monomer with Poly Melamine Urea Formaldehyde (PMUF) shells are synthesized using the in situ interfacial polymerization reaction [1]. As the size of the microcapsules are very important for self healing of composite parts, the agitation speed of the emulsion and the duration of ultrasonication were varied to regulate the distribution of sizes of microcapsules. To avoid the tendency of agglomeration during the manufacturing of small microcapsules with this process, the amount and concentration of the emulsifier and surfactant were varied and optimum values were established to produce separated individual microcapsules of average size less than 15 microns (Fig. 1).

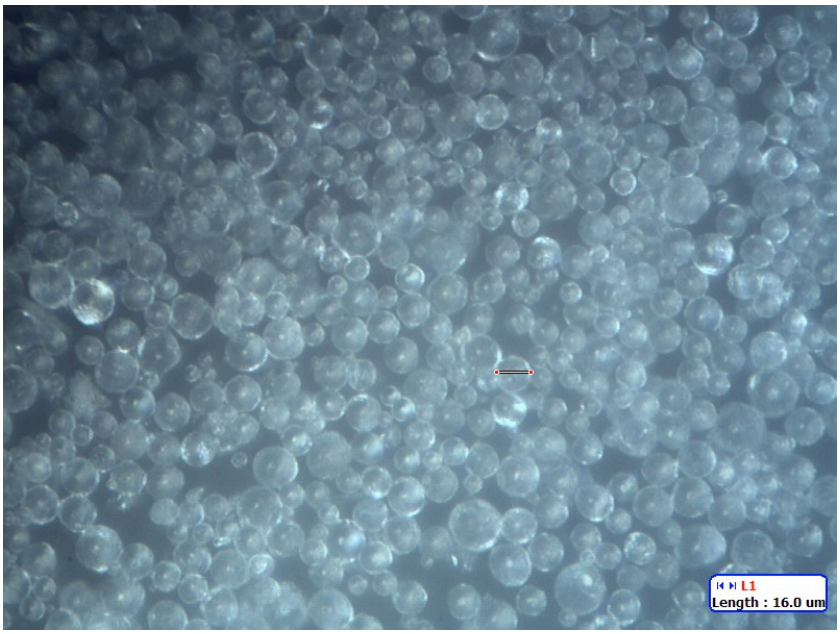

Figure 1: Separated individual microcapsules of average size less than 15 microns (Optical, 200X).

Grubbs catalyst and microcapsules were blended with Epon 828 and Epicure 3046 using a vacuum centrifuging technique following a mixing scheme. The blend was then poured into silicone mold to fabricate self healing resin samples without fibers. The same blend was infused into the layers of carbon fibers to fabricate self healing cross-ply composite specimens using an autoclave. The resin specimens as well as the composite specimens were then impacted with high velocity (600-700 m/s) metal projectiles using a high pressure gas gun.

After the high velocity impact, the extent of damages, network of cracks and extent of self healing were visually observed and analyzed with the resin samples (Fig. 2).

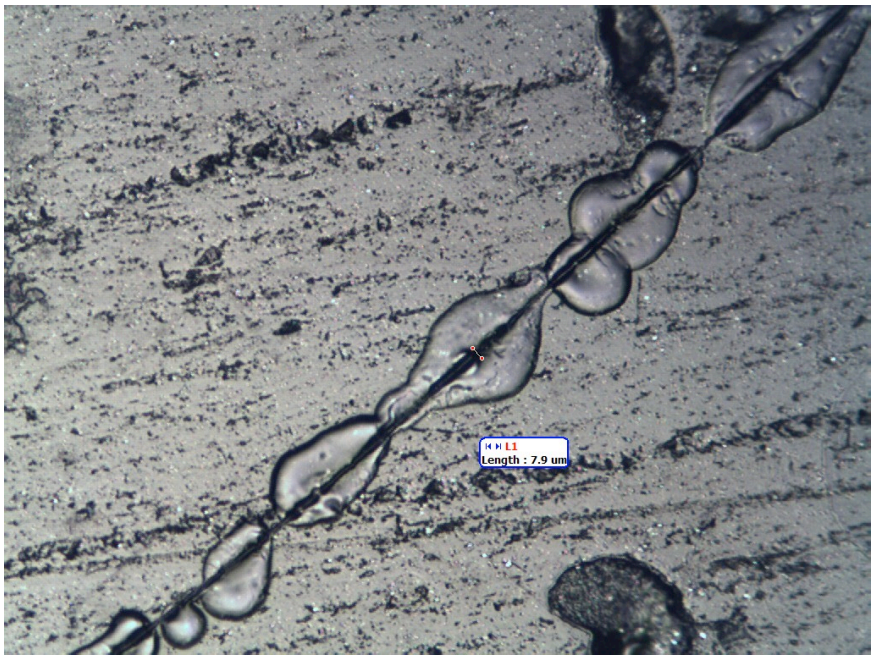

Figure 2: Healing of cracks of resin samples (Optical, 200X).

After the high velocity impact on the regular (without self healing agent) and modified (with self healing agents) Carbon Fiber Reinforced Polymer (CFRP) composite specimens, three-point bending tests were performed following the ASTM D7264 standard. Healing performance was then evaluated by comparing the flexural properties of the self healing (modified) and non-healing (regular) composite samples. It is found that the modified samples recover the strength of the regular samples after self healing.

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REFERENCES

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