TABLE 1 AGITATION RATES AND MICROCAPSULES' OBTAINED SIZE

Agitation Rate (rpm)	Average Size Dv90 (μm)
400	151
500	137
600	42
700	50

capsules, scanning electron microscope (SEM) and optical microscope (OM) were used. Microcapsules' surface, microstructure details, and diameter sizes were obtained. As a variety of sizes was detected, the dynamic light scattering (DLS) technique was also used to determine the size distribution profile of the microcapsules.

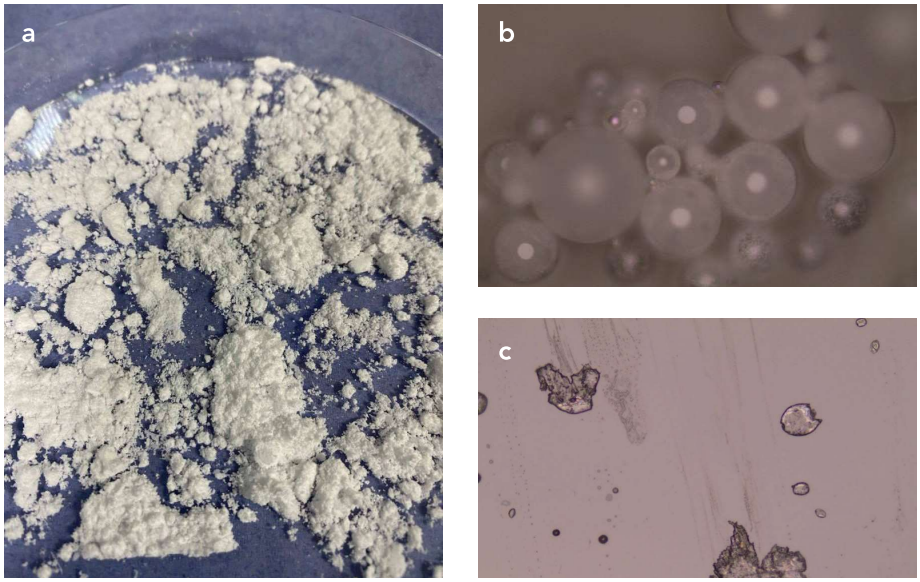

FIGURE 3 (a) The obtained microcapsules after being fully dried in room temperature. (b) Microcapsules under OM. (c) The release of the corrosion inhibitor after the manual rupture of the microcapsules. Image under OM.

Results And Discussion

Figure 2 represents the new coating system that will be developed. The metallic substrate is CS (S355), followed by TSZ (85 wt.% Zn, 15 wt.% Al wire alloyed composition) coating. After the application of a primer for better adhesion of the paint, the topcoat will be applied. This will consist of marine epoxy paint enriched with the formatted microcapsules.

After the separation of the microcapsules from the liquid medium and their cleaning with ethanol, the product was allowed to fully dry. A white and fine powder of around 5 g was obtained, as observed in Figure 3(a). After examination under OM [Figure 3(b)] and SEM, mononuclear microcapsules with a single inner cavity were observed. The DLS technique was used, and a variety of diameter sizes was observed. From this analysis, it was decided that the agitation rate to obtain 80 to 100 μm capsules is between 400 and 500 rpm, as observed in Table 1. The successful encapsulation of the silanol was confirmed from the rupture of the polystyrene shell and the release of the liquid in Figure 3(c).

It is notable that when higher speeds were used, 700 and 800 rpm, nanoscale microcapsules were formed. This observation can be related to surface tension and shear force phenomena or silanol concentration.[9] Finally, the selection of the surfactant for the emulsion formation as well as the addition of the reagents into the reaction solution had a crucial importance for the shape and size of the microcapsules.

Conclusions

The microcapsules that were formed from the solvent evaporation from a double emulsion technique had a variety of sizes. The optimum size was achieved when 400 and 500 rpm magnetic stirring was implemented. Spherical, one-core and loaded with corrosion inhibitor microcapsules were developed. Images from OM and SEM showed a spherical and well-built outer shell of the microspheres. To confirm that they were loaded with corrosion inhibitor liquid, some of them were intentionally ruptured with a spatula. The release of liquid confirmed the successful experimental procedure. Sieves with specific diameter will be used for the separation of the various sizes of microcapsules prior to their incorporation into the marine paint. Exposure in corrosive conditions and monitoring of the chemical reactions will give valuable information regarding the anticorrosive and self-healing properties of the newly developed system in this ongoing research.

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