23. A microstructure-based approach towards cold sprayed composite coating quality assessment

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Cold spraying as an emerging coating technology in the surface engineering field, can deposit a wide range of feedstock materials. Particularly, it is possible to yield an integrated deposit dense enough comparable to bulk materials. On the other hand, microstructure plays a crucial role in performance and properties of materials. The vitality of microstructural studies applies here as well; the assurance of cold sprayed coating quality is not feasible without a through characterization of the microstructure [1].

In the current research, the integrity of cold sprayed Al-based composite coating was assessed by employing structural characterization techniques. A high-pressure cold spray system was used to fabricate the composite coating from hard quasicrystalline powders premixed with Al-based powders on aluminium substrate. The same cold spray process parameters were also used to make an Al-based coating counterpart. The achieved coatings were exposed to cavitation erosion following the recommended procedure in ASTM Test Method G32-16 modified [2]. As the result of cavitation bubbles formation, micro-explosion over the surface of the coatings causes gradual damage to the coating. This process can be used to define the cohesion of the sprayed coating and highlight the weak spots in the microstructure after a certain exposure duration. Scanning electron microscopy (SEM) micrographs in Figure 1 from the coatings after 30 minutes of cavitation can be compared with the sprayed coatings before cavitation. Horizontal cracks generated at the grains and particle boundaries were remarkably eliminated in cross-sections when the quasicrystalline particles (bright phases) were embedded inside the coating. Topography images showed that the ultimate detachment of large segments of loosely connected powders could be responsible for the emergence of deep cavities of Al-coating; while a different kind of morphology can be seen over composite coating. An optical profilometer was also used to investigate the extent of the surface damage (Figure 1). In accordance with SEM images of the eroded surface, the cavitation erosion volume loss of the cold-sprayed Al-based coating with large and deep cavities was considerably higher than that of the Al-quasicrystalline composite coating.

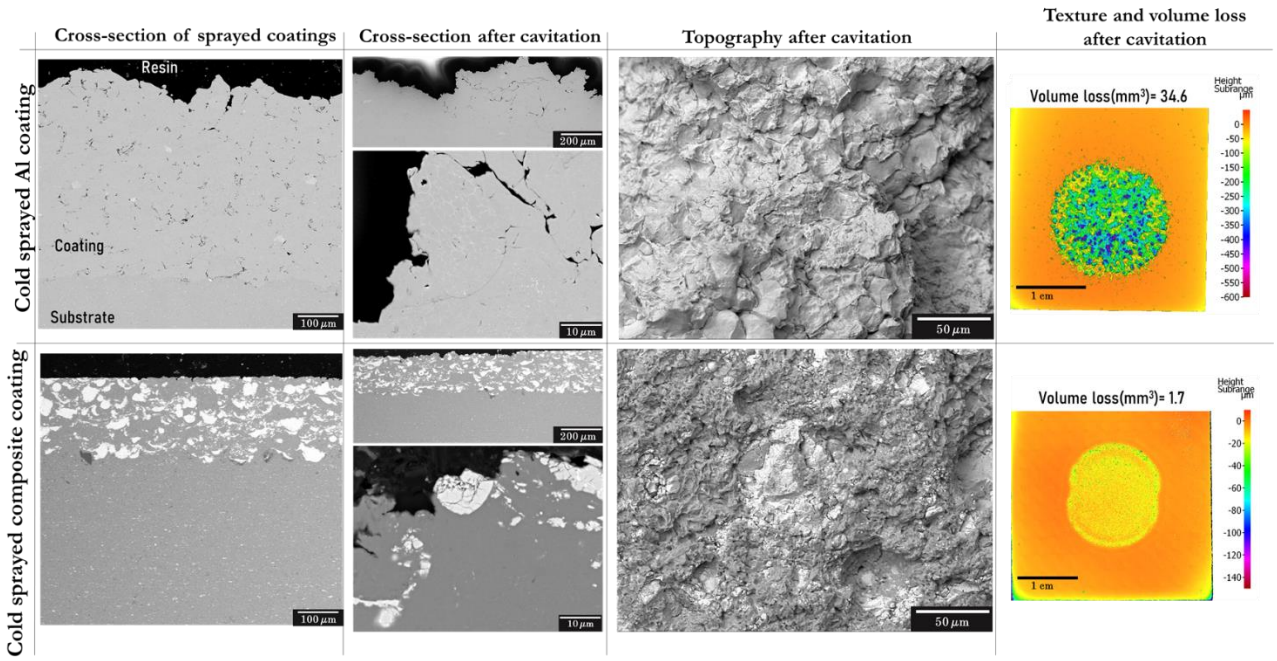

Figure 15 SEM images of tested cold sprayed coatings before and after 30 minutes exposure to cavitation erosion and 2D texture and volume loss from damaged area showing the extend of degradation.

To conclude, Al-quasicrystalline composite coating was made using cold spraying. The utilized microstructural characterization confirmed the positive role of hard quasicrystalline powders in the densification and enhanced microstructural integrity of the composite coating compared to Al-based coating counterpart.

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[2] W. Conshohocken, Standard Test Method for Cavitation Erosion Using Vibratory Apparatus G 32, in: Annu. B. ASTM Stand., 2010: pp. 1–18. https://doi.org/10.1520/G0032-16.