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### Effect of nanostructure on the tribological properties of alumina-titania coatings

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Alumina-titania coatings are used where a high wear and oxidation resistances are required. Examples of these applications are pistons in pumps or internal combustion engines and steam valve spindles. These coatings are usually deposited by thermal spraying. The use of nanoparticles as feeding powders can lead to improved properties if some technological problems are solved. The small size of the nanoparticles makes necessary to prepare agglomerates able to be sprayed by conventional equipments. The plasma spray parameters should be chosen to maintain the starting nanostructure in the final coating. This can be achieved if the coating contains partially melted particles.

Depth sensing indentation and wear tests show that although hardness and Young's modulus are slightly higher in the nanostructured coatings, they exhibit a much better wear behaviour under all the testing conditions.

The SEM analysis of the worn surfaces of the samples tested at low temperatures reveals the activation of a brittle crack propagation mechanism. Thus, the fracture toughness of the coatings seems to be the key variable to explain the enhanced wear response of the nanocoating. From the experiments, it is evident that the hierarchical microstructure plays a toughening role. The partially melted particles act as a tough reinforcement obliging the cracks to deflect around them leading to an increase in the fracture toughness and to an improved response in the tribological behaviour.

At high temperatures worn surfaces show plastically deformed zones and areas in which crack propagation is active. The combination of these two phenomena makes difficult to identify a dominant wear mechanism. However, the hierarchical microstructure of the coating can partially justify the observed trends.