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Damage Evolution and Mechanism of TiN/Ti Multilayer Coatings in Sand Erosion Condition

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Abstract: To study the sand erosion damage evolution and mechanism of TiN/Ti multilayer coatings, the coatings with period numbers of 1, 2, 4 and 8, were deposited by combining the techniques of FCVA and MEVVA ion implantation. The coatings were evaluated via nano-indentation and scratcher, and numerical simulations and sand erosion experiments were conducted. All of the coatings show quite high adhesion strengths of ~80 N. Besides, it was found that the deposited defects could lead to premature failure of coating. In the absence of defects, attributing to the maximum tensile stress and highest stress gradient in the exposed topmost TiN layer, the TiN/Ti coatings are generally eroded off as layered. The simulation results showed the high tensile stress distributing on the surface and undersurface of every TiN layer were probably the main factors for crack initiation and brittle flaking. Accordingly, the TiN/Ti coating with one period performed the best erosion resistance, while the coating with eight periods showed the worst performance. These results indicate that based on the high adhesion strength and few defects, the fewer TiN layers in coating, the fewer vulnerable regions with high tensile stress, and resulting in better sand erosion resistance.

Keywords：Sand erosion condition; Damage evolution; Damage mechanism; TiN/Ti multilayer coating; Period number.

1. Introduction

For the helicopters which taking off or low-altitude flying in dusty regions, plenty of sands will flow into aero-engines together with compressed gas. The ingested sand erodes compressor blades continually and produces severe erosion damage, leading to increasing oil consumption, lower efficiency and higher maintenance costs [1-3]. In particular, because of the severe sand erosion damage, the service lifetimes of aero-engines in Operation Desert Storm have plunged to less than one-eighth of the design lifetimes [4]. With the development of material surface

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