# Microstructure change, element diffusion and tribological properties of chromium oxide coatings from RT to 1000 °C

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The demands of reusable solid lubricants with continuous lubricating properties from room temperature (RT) to 1000 °C or even higher temperatures become increasingly urgent with the development of high-tech industries, especially that of aerospace industry. In our work, chromium oxide was investigated as a primary coating because it possesses high melting point and excellent thermal stability. The chromium oxide coatings were deposited on Ni-based high-temperature alloy substrates through an arc ion plating system and then annealed at 1000 °C in air for 2 h. The effects of annealing on the structure and tribological properties in wide temperature range of $Cr_2O_3$ coating were researched in detail. The phase change and elements diffusion behavior of $Cr_2O_3$ coating annealed at 1000 °C were also discussed. Main results and conclusions are as-followed:

Ti and Cr atoms in the Inconel 718 alloy matrix diffuse to the coating surface and react with oxygen in atmosphere, thereby generating the mesh-like heave structure (Fig1 and Fig2) that endues the annealed coating an excellent self-lubricating behavior in wide temperature range. The friction coefficients are all lower than 0.3, and the wear rates maintain at a magnitude of $10^{-7}$ $mm^3/Nm$ from RT to 1000 °C (Fig3). Particularly, the excellent self-lubricating performance could be maintained even in five-thermal-cycles test. Moreover, while the mesh-like heave structure damaged by friction, Ti and Cr atoms in the matrix tend to diffuse to the damaged locations and react with oxygen in air. This phenomenon results in the reproduction of composite-phase heave structure of $Cr_2O_3$ and $Cr_2Ti_4O_{17}$ at the damaged locations. Consequently, the self-supplement ability of the mesh-like heave structure could prolong the wear life in wide temperature range.

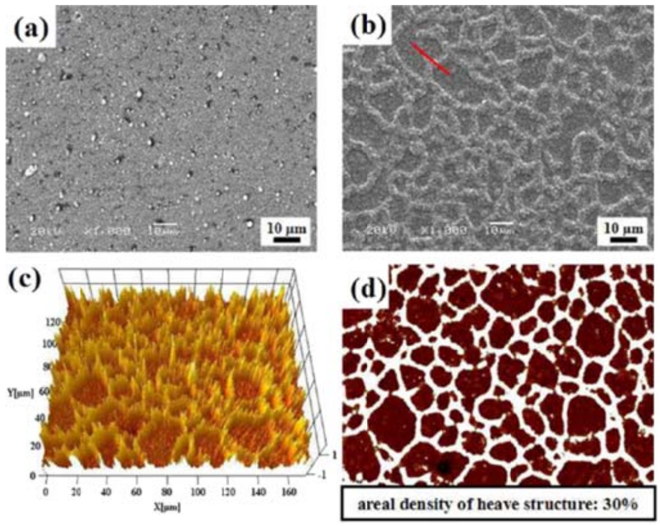


Fig 1. (a) Surface morphology of as-deposited coating, (b) surface morphology of the annealed coating (1000 °C, 2 h), (c) three-dimensional profile of the annealed coating, (d) areal density of the heave region

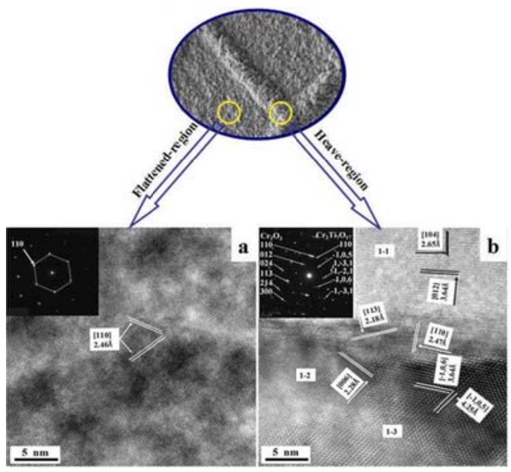


Fig 2. HRTEM images and corresponding selected area electron diffraction patterns of the annealed coating (a) the flattened region, (b) the heave region

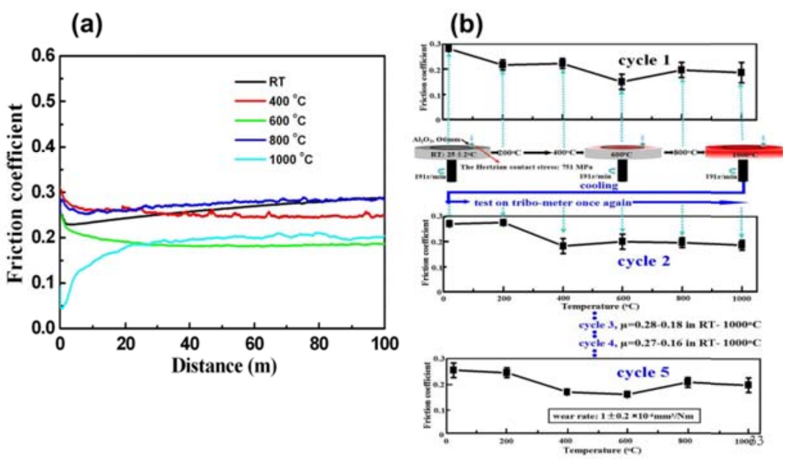


Fig 3. (a)The typical friction traces and (b) the cycle test of the annealed coating from 25 to 1000 °C sliding against $Al_2O_3$ balls