SELF-HEALING AND HIGH-TEMPERATURE OXIDATION OF NANO-NI DISPERSED AL₂O₃ HYBRID MATERIALS

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ABSTRACT

Al₂O₃ hybrid materials dispersed with Ni nano-particles (referred to as Ni/Al₂O₃) have excellent mechanical properties with crack-healing function via a thermal oxidation process. In using Ni/Al₂O₃ at high temperatures in oxidizing atmosphere, nano-Ni particles dispersed in Al₂O₃ matrix are oxidized with Al₂O₃ matrix into NiAl₂O₄. An oxidized zone consisting of NiAl₂O₄ grains and Al₂O₃ matrix is developed and grown from the surface mainly via inward diffusion of oxide ions at grain boundaries. At the same time, Ni ions are diffused at the grain boundaries from the inside to the surface to form an NiAl₂O₄ layer, which fills cracks for self-healing. Because oxidation of Ni nano-particles means disappearance of metallic Ni in Al₂O₃ matrix, high-temperature oxidation of Ni/Al₂O₃ may degrade their self-healing performance. In order to use Ni/Al₂O₃ in high-temperature structural applications, kinetics on high-temperature oxidation and self-healing of Ni/Al₂O₃ were discussed in the present report. Effects of dopants such as Y₂O₃ and SiO₂ on high-temperature oxidation and self-healing are also described.