

# SELF-HEALING AND HIGH-TEMPERATURE OXIDATION OF NANO-NI DISPERSED $\text{Al}_2\text{O}_3$ HYBRID MATERIALS

M. Nanko<sup>1</sup> and D. Maruoka<sup>2</sup>

<sup>1</sup> Department of Mechanical Engineering, Nagaoka University of Technology, Nagaoka, Niigata, 940-2188, Japan – e-mail: nanko@mech.nagaokaut.ac.jp

<sup>2</sup> Graduate School of Engineering, Nagaoka University of Technology, Nagaoka, Niigata, 940-2188, Japan – e-mail: daisuke@stn.nagaokaut.ac.jp

Keywords: ceramics, self-healing, high-temperature oxidation, nickel, alumina

## ABSTRACT

$\text{Al}_2\text{O}_3$  hybrid materials dispersed with Ni nano-particles (referred to as Ni/ $\text{Al}_2\text{O}_3$ ) have excellent mechanical properties with crack-healing function via a thermal oxidation process. In using Ni/ $\text{Al}_2\text{O}_3$  at high temperatures in oxidizing atmosphere, nano-Ni particles dispersed in  $\text{Al}_2\text{O}_3$  matrix are oxidized with  $\text{Al}_2\text{O}_3$  matrix into  $\text{NiAl}_2\text{O}_4$ . An oxidized zone consisting of  $\text{NiAl}_2\text{O}_4$  grains and  $\text{Al}_2\text{O}_3$  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  $\text{NiAl}_2\text{O}_4$  layer, which fills cracks for self-healing. Because oxidation of Ni nano-particles means disappearance of metallic Ni in  $\text{Al}_2\text{O}_3$  matrix, high-temperature oxidation of Ni/ $\text{Al}_2\text{O}_3$  may degrade their self-healing performance. In order to use Ni/ $\text{Al}_2\text{O}_3$  in high-temperature structural applications, kinetics on high-temperature oxidation and self-healing of Ni/ $\text{Al}_2\text{O}_3$  were discussed in the present report. Effects of dopants such as  $\text{Y}_2\text{O}_3$  and  $\text{SiO}_2$  on high-temperature oxidation and self-healing are also described.