

EFFECT OF DY ADDITION ON THE HIGH-TEMPERATURE OXIDATION BEHAVIOR OF POROUS NI-AL ALLOY MADE BY COMBUSTION SYNTHESIS*

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Ni-Al intermetallic alloys have superior high-temperature properties, such as excellent oxidation resistance and high yield strength. They are particularly attractive for fabricating porous components of energy conversion and combustion devices. However, at temperatures above 1100 °C, the Ni-Al alloy is subject to the effect of oxide scale peeling under thermal cycling conditions. The addition of chromium to Ni₃Al makes it possible to increase the stability of the oxide scale under cyclic oxidation conditions up to temperatures of ~1150 °C [1]. Another well-accepted way to increase the resistance of the oxide scale to the spallation is to dope the alloy with rare earth elements (REE) of the order of 0.1 wt% [2]. Estimates show that using porous structures with a strut size of more than 1 mm is necessary to ensure a one-year lifetime at a temperature of 1100 °C. Combustion synthesis is an energy-efficient technique to produce mm-size Ni-Al intermetallics from self-sustained exothermic reactions between the elemental powders. The oxidation patterns of porous Ni-Al materials have been poorly studied [3]. The motivation of this work is to study the oxidation resistance of combustion synthesized porous Ni-Al micro-alloyed with REE (Dy).

Combustion synthesized porous alloys of the following composition were examined: Ni + 38 at.% Al, Ni + 38 at.% Al + 0.05 at.% Dy and Ni + 38 at.% Al + 0.1 at.% Dy. The following powders were used as starting reagents: nickel grade PNC UT-1 (Nornickel), aluminum grade PA-4 (Rusal), and Al-Dy core-shell particles by electron beam treatment [4]. The cyclic oxidation tests were conducted in air at 1150 °C.

The results showed that Dy is mainly released as particles along grain boundaries and closed pores, preventing oxygen from passing inside the alloy at high temperatures. The use of core-shell Al-Dy particles as an additive to the initial reaction mixture allowed Dy to be evenly distributed over the porous structure of the alloy. Cyclic oxidation of the Ni-Al-Dy porous alloy at a temperature of 1150 °C in air compared to Ni-Al alloys exhibited a twofold increased oxidation resistance because of decreased scale spallation.

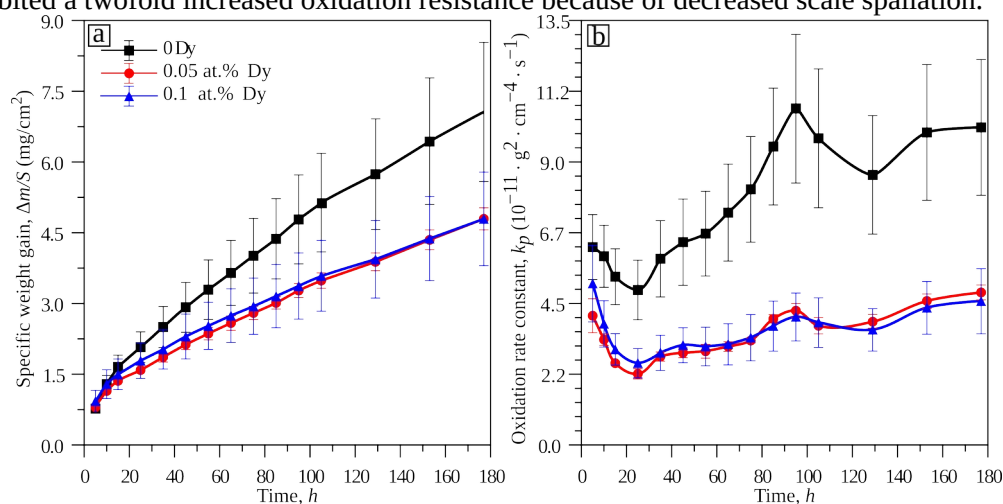


Fig.1. The evolution of the specific weight gain (a) and oxidation rate constant (b) with time.

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