

Hydrogen embrittlement of iron-based Fe-Ni-Al-alloys

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Iron-based alloys, often referred as ferritic superalloys, are a promising class of high-temperature alloys due to their low density, low costs, and excellent mechanical properties up to temperatures of 700 °C. Possible interesting applications are power-generating turbines and steam turbines [1]. The wide range of the existing and potential applications of the Fe-Ni-Al system is attributed to their desired properties, such as a high melting point and good oxidation resistance [2], as well as an attractive price. However, the major drawbacks of this group of alloys are enhanced brittleness and poor ductility at room temperature [2, 3]. As hydrogen also causes embrittlement, the effect of hydrogen on such sensitive materials needs fundamental understanding.

The main aim of the present study is to investigate hydrogen influence on mechanical properties of Fe-rich Fe-Ni-Al alloys at room temperature. In this regard, the alloys consisting of 65 at-% iron and varying content of nickel and aluminium are considered. After solution heat treatment and ageing, the samples have a bcc ferritic matrix [2]. The hydrogen effect was studied by cathodic hydrogen charging of the alloy in an aqueous sulphuric acid solution by varying the current density and charging time. The influence of hydrogen on the considered alloys was investigated by studying their mechanical properties for each charging mode and related to the corresponding hydrogen concentration.

Keywords: hydrogen embrittlement, mechanical properties, iron-based alloys, Fe-Ni-Al alloys

References:

1. P. Liaw, G. Ghosh, M. Asta, M. Fine, and C. Liu, "Computational design and prototype evaluation of aluminide-strengthened ferritic superalloys for power-generating turbine applications up to 1,033 K," Univ. of Tennessee, Knoxville, TN (United States), 2010.
2. E. Contreras-Piedras, H. J. Dorantes-Rosales, V. M. López-Hirata, F. Hernández Santiago, J. L. González-Velázquez, and F. I. López-Monroy, "Analysis of precipitation in Fe-rich Fe–Ni–Al alloys by diffusion couples," *Materials Science and Engineering: A*, vol. 558, pp. 366–370, 2012, doi: 10.1016/j.msea.2012.08.013.
3. Hector J. Dorantes-Rosales, Victor M. Lopez-Hirata, Jorge L. Gonzalez-Velazquez, Nicolas Cayetano-Castro, and Maribel L. Saucedo-Muñoz, "Precipitation Process in Fe-Ni-Al-based Alloys," in *Superalloys*, Mahmood Aliofkhazraei, Ed., Rijeka: IntechOpen, 2015, Ch. 4.