Evaluation of the role of aging on mechanical properties of a Ni-Based Superalloy using Nanoindentation

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Abstract

Haynes 282 (HY282) alloy is a Ni-based superalloy, which is a potential candidate for the advanced-ultra supercritical (A-USC) boilers in power plants. The present work aims to study the effect of isothermal aging on the mechanical properties of HY282 using nanoindentation at room temperature and at temperatures in the range 200-800 ^{o}C. The alloy was exposed to 750 and 800°C, consistent with temperatures of concern for A-USC applications, for different durations ranging from 5 to 1000 h. A significant effect of the temperature and duration of aging was observed on γ' precipitate size and shape, which in turn influenced the mechanical properties, such as hardness and overall elastic modulus, of the alloy. Subsequently, room temperature indentation tests were performed on the heated treated alloys, to determine the mechanical properties for the individual grains, having one of the three primary orientations, namely {100}, {110} or {111}. This approach helps to determine the anisotropy in mechanical properties of this alloy. The elastic stiffness constants were evaluated using the indentation modulus by least square fitting, as per the model proposed by Vlassak and Nix [1] and further simplified by Delafargue and Ulm [2]. The values obtained were consistent with those of similar superalloys obtained from conventional testing techniques. This validates the utility of using nanoindentation on polycrystalline materials as an alternative method to obtain the complete elastic moduli tensor of a material. The indent topography was further analyzed using scanning probe microscope to understand the variation of hardness of differently aged samples. The effect of different precipitate size formed due to different ageing, on high temperature nanoindentation behavior will also be discussed.

Keywords: Nanoindentation, Superalloy, Elastic modulus, Anisotropy, High Temperature Testing.

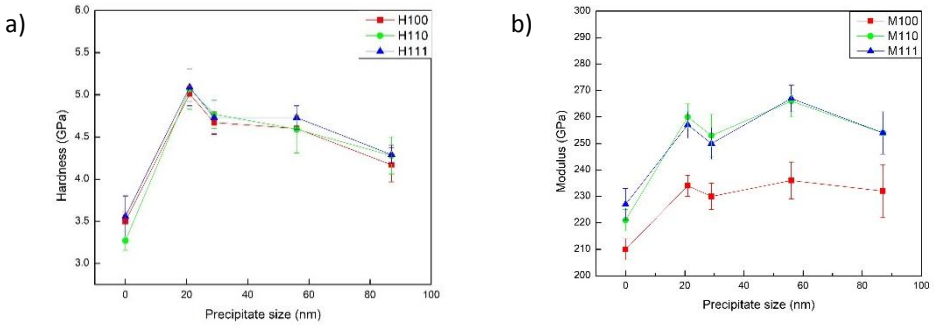

Fig.1 RT Nanoindentation results of samples aged at 800°C. a) Variation of Hardness b) Variation of Indentation Modulus.

References:

[1] Joost J. Vlassak and W. D. Nix, Measuring the Elastic Properties of Anisotropic Materials by Means of Indentation Experiments, J. Mech. Phys. Solids, Vol. 42, No. 8. pp. 1223-1245, 1994.

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