doi:10.1017/S1431927613006715
Microsc. Microanal. 19 (Suppl 2), 2013

Direct Atomic Scale Observation of the Structure and Chemistry of Order/Disorder γ'/γ Interfaces in Nickel Base Superalloys

S. Meher[1], S. Nag[1], R. E. A. Williams[2], R. Srinivasan[3], H. L. Fraser[2], and, R. Banerjee[1]

1. Center for Advanced Research and Technology and Department of Materials Science and Engineering University of North Texas, Denton, Texas, USA
2. Center for the Accelerated Maturation of Materials and Department of Materials Science and Engineering The Ohio State University, Columbus, Ohio, USA
3. ExxonMobil Research and Engineering Company Annandale, New Jersey 08801, USA

In high temperature materials, such as nickel base superalloys, the interface between the ordered gamma prime precipitate and the disordered gamma matrix plays a critical role in determining its high temperature microstructural stability, including the rate of precipitate coarsening, and its mechanical properties, including the attendant strengthening mechanisms. Prior atomistic simulations [1,2] show that the gamma/gamma prime interface is not abrupt.

Combining atom probe tomography (APT), carried out in an local electrode atom probe (LEAP) system from Cameca Inc. with aberration-corrected high resolution scanning transmission electron microscopy (HRSTEM), carried out using a high angle annular dark-field (HAADF) detector in an FEI TITAN microscope, the atomic scale structure and chemistry across the order/disorder interface in a nickel base superalloy has been determined [3]. These investigations clearly reveal the presence of two interface widths; one corresponds to the order-disorder transition, while the other corresponds to the compositional gradient across the interface. While, the order/disorder interface is ~ 6-8 atomic layers thick, the width of the compositional gradient across the same interface is ~ 12-14 atomic layers thick, raising fundamental questions regarding the definition of these interfaces. Furthermore, the role of these partially ordered interfaces as possible diffusion barriers during the growth and coarsening of the gamma prime precipitates will also be briefly discussed.

Similar coarsening studies were conducted on model Ni-14at%Al-7at%Cr alloy using atom probe tomography (APT) and transmission electron microscopy (TEM). Thus on isothermal annealing at 800ºC, the ternary alloy shows a gradual decrease in gamma/gamma prime interface width, with an enhancement of solute partitioning across it and accelerated growth of gamma prime precipitates [4]. With further ageing there is no substantial change in the interface profile and the coarsening rate appears to follow predictions afforded by the classical LSW theory.

References:
1. A.J. Ardell, V. Ozolins, *Nat. Mater.* **4**, 309 (2005).
2. Y. Mishin, *Acta Mater*. **52**, 1451 (2004).
3. R. Srinivasan, R. Banerjee, J.Y. Hwang, G.B. Viswanathan, J. Tiley, D.M. Dimiduk and H.L. Fraser "Atomic Scale Structure and Chemical Composition across Order-Disorder Interfaces", *Physical Review Letters*, **102**(24), 086101 (2009).
4. S.Meher, T. Rojhirunsakool, J.Y. Hwang, S. Nag, J.Tiley, R. Banerjee, "Coarsening behavior of Gamma Prime Precipitates and Concurrent Transitions in the Interface Width in Ni-14 at%Al-7 at%Cr", submitted to *Philos. Mag. Letters* (2013).

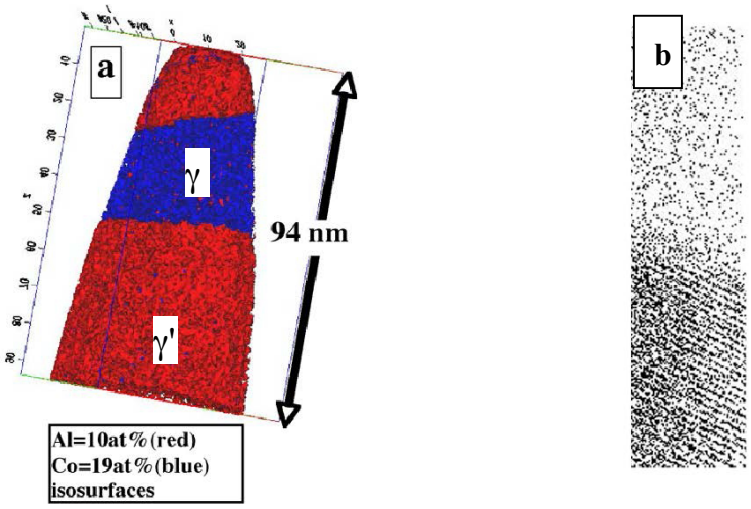

Figure 1. (a) Al (red) and Co (blue) isosurfaces depicting morphology of the gamma prime precipitate used in Atom probe tomography analysis. (b) Higher magnification views showing the stacking of alternate (002) Al planes within the gamma prime precipitate.[3]

https://doi.org/10.1017/S1431927613006715 Published online by Cambridge University Press