doi: 10.1017/S1431927609097086
Microsc Microanal 15(Suppl 2), 2009

Study of compositional gradients across the γ/γ' interface in Ni-base superalloys using 3D Atom Probe Tomography

J. Y. Hwang, S. Nag, A.R.P. Singh, G.B. Viswanathan[#], J. Tiley*, R. Srinivasan[#], H. L. Fraser[#], R. Banerjee

Center for Advanced Research and Technology and Department of Materials Science and Engineering. University of North Texas, Denton TX 76207
[#]Center for the Accelerated Maturation of Materials and Department of Materials Science and Engineering, The Ohio State University, Columbus OH 43210
*Materials and Manufacturing Directorate, Air Force Research Laboratory, Dayton, Ohio

The role of the interface width and compositional transitions across the interface is of particular interest in multicomponent Ni-base superalloys, since these factors can influence important processes such as the coarsening kinetics [1], which in turn can affect the overall mechanical properties [2,3]. Prior atomistic simulations [1,4] and experimental observations [5] show that the γ/γ' interface is not abrupt, but has a definite transition width, comprising of an order-disorder, and a compositional component [5]. With this background, it becomes imperative to understand the dependence of interface width in these superalloys, as a function of various thermomechanical processing conditions.

This study focuses on the understanding of the compositional gradients of the primary alloying elements, Al, Cr, Co, Mo and Ti, across the γ/γ' interface in Rene' 88 DT, a multicomponent Ni-base superalloy. The precipitates of the ordered $L1_2$ γ' phase can have varying sizes and morphologies depending upon the cooling rates experienced from a supersolvus annealing treatment, and subsequent aging treatments [6]. Figure 1 shows an energy filtered TEM (EFTEM) image (using the Cr M-edge) of the typical bimodal distribution of γ' precipitates (darker phase) in Rene' 88 DT slow-cooled from the supersolvus annealing temperature. The larger precipitates are referred to as primary γ', while the smaller ones are the secondary γ'. The compositional gradient (as measured using 3DAP Tomography) of key alloying elements across the matrix/primary γ' interface is shown in Figure 2 based on a proximity histogram (or proxigram) analysis [7]. As seen in Figure 2, the "compositional" interface width is ~ 0.6 nm, using Cr as a basis. A measurement of the interface width across the matrix/secondary γ' interface, in the same sample, yields a substantially larger value of ~ 3.8 nm. This difference can be possibly attributed to the different undercoolings (below the γ' solvus temperature) associated with the formation of primary and secondary γ' precipitates. A detailed study of the size and compositional evolution of primary and secondary γ' precipitates as a function of cooling rate and aging at 760°C will be presented.

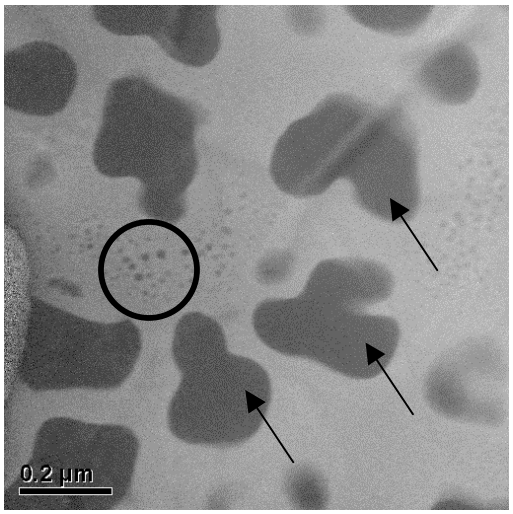

Figure 1. EFTEM image (using Cr-M edge) showing primary (indicated by arrows) and secondary (circled) γ' precipitates in slow-cooled Rene' 88 DT

References

1.A.J. Ardell, V. Ozolins, Nat. Mater. **4**, 309 (2005).

2.N.S. Stoloff, in *Superalloys II*, ed. C.T. Sims, N.S. Stoloff, W.C. Hagel, John Wiley and Sons, New York, 61 (1987).
3.G.B. Viswanathan, P.M. Sarosi, M.F. Henry, D.D. Whitis, W.W. Milligan, M.J. Mills, Acta Mater. **53**, 3041 (2005).
4.Y. Mishin, Acta Mater. **52**, 1451 (2004).
5.R. Srinivasan et al., to be published in Phys. Rev. Lett.
6.J. Tiley et al., to be published in Acta Mater.
7.O.C. Hellman, J.A. Vandenbroucke, J. Rüsing, D. Isheim, D.N. Seidman, Micros. Microanal. **6**, 437 (2000).

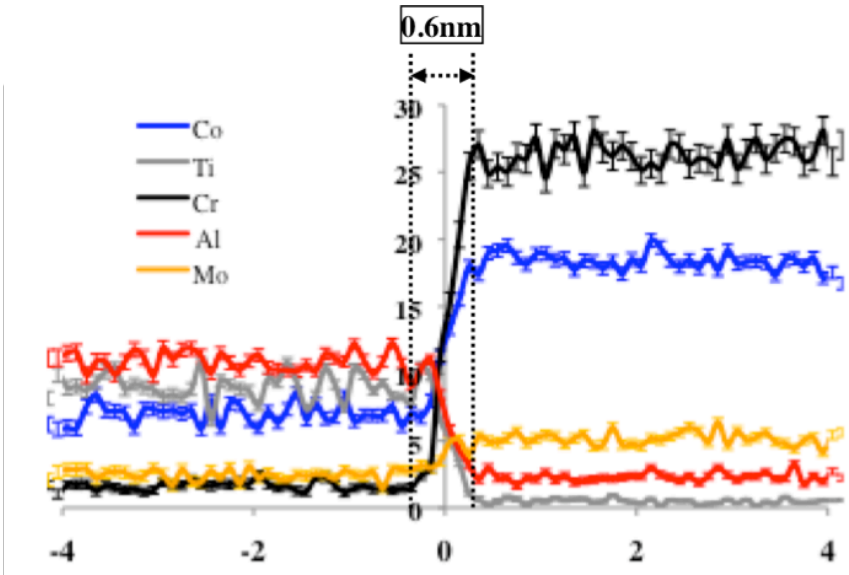

Figure 2. Compositional gradients (proxigrams) of primary alloying elements across the primary γ' / matrix γ interface plotted for the un-aged, slow-cooled Rene' 88 DT sample.

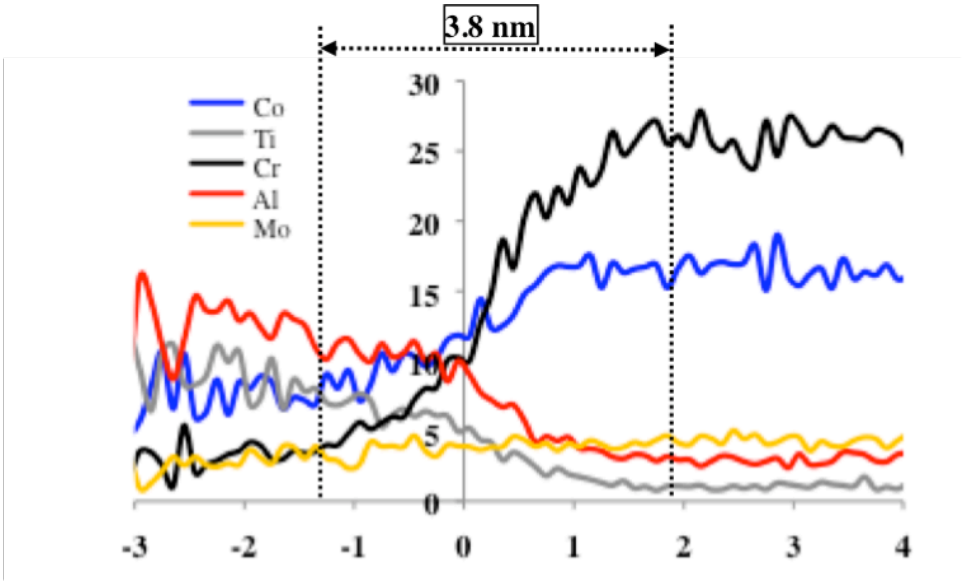

Figure 3. Compositional gradients (proxigrams) of primary alloying elements across the secondary γ' / matrix γ interface plotted for the un-aged, slow-cooled Rene' 88 DT sample.

https://doi.org/10.1017/S1431927609097086 Published online by Cambridge University Press