Direct Atomic Scale Observation of the Structure and Composition Across Order/Disorder Gamma Prime/Gamma Interfaces in Nickel Base Superalloys

R. Srinivasan, R. Banerjee*, J. Y. Hwang*, G. B. Viswanathan, J. Tiley[#], D.M. Dimiduk[#] and H. L. Fraser

Center for the Accelerated Maturation of Materials, Department of Materials Science and Engineering, The Ohio State University, Columbus, Ohio 43210, U. S. A.

*Center for Advanced Research and Technology, Department of Materials Science and Engineering, University of North Texas, Denton, Texas 76203, U. S. A.

[#]Materials and Manufacturing Directorate, Air Force Research Laboratory, Dayton, Ohio 45309, U. S. A.

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. Combining 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, with three-dimensional atom probe (3DAP) tomography, carried out in an local electrode atom probe (LEAP) system from Imago Inc., the atomic scale structure and chemistry across the order/disorder interface in a nickel base superalloy has been determined. 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.