Understanding structure of dispersoids in oxide dispersion strengthens materials

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Abstract:

Oxide dispersion strengthened (ODS) alloys are possibly the most promising next generation high strength structural materials. The authors have been involved for a decade in developing a host of such materials including ODS ferritic and ferritic-martensitic steels and Ni base super alloys using powder metallurgical (PM) processes. In all cases, the dispersoids are basically made of yttria owing to their exceptional high temperature stability. Although bcc phase of yttria is the stable phase at room temperature, our recent results show that it transforms to a metastable monoclinic phase during high energy ball milling, a mandatory PM step to production of ODS materials. It has also been observed that to react with other oxide forming matrix elements selectively during the high temperature PM processing steps to form complex oxides. These fine complex oxide particles impart high temperature creep strength to the material by impeding motion of dislocations. Therefore it is of utmost importance to learn in detail about their structure and chemistry down to atomistic detail. In this presentation, some recent results of probe-aberration-corrected sub-Å resolution TEM imaging of the dispersoids will be discussed. Intriguing aspects of transformation of the ball-mill induced metastable monoclinic yttria back to its cubic phase during in-situ heating experiments in XRD and TEM will also be discussed.