Development of Austenitic ODS Strengthened Alloys for Very High Temperature Applications

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Program: Mission Supporting

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ABSTRACT

This research program will develop an understanding of the microstructural and micromechanical processes which control high temperature materials performance in austenitic oxide dispersion strengthened (ODS) alloys. While substantial progress has been made on ferritic ODS alloys, there has been much less attention directed toward the development of the austenitic ODS systems. Nevertheless, the austenitic ODS systems are essential to meet very high temperature reactor conditions where creep strength is a critical property above 850C, the likely upper temperature limit of precipitation strengthened austenitic alloys like Alloy 617 and Alloy 230 which are the current leading candidates for very high temperature gas-cooled reactor (VHTR) applications. This program will take the necessary steps toward developing a creep and corrosion resistant ODS alloy for applications up to 1000C in heat exchange and structural applications. This goal will be accomplished by understanding the microstructural level deformation processes at the particle level which control dislocation-particle interactions, the controlling factor in developing creep resistance. The accompanying role of grain boundaries and boundary dislocation structures will also be examined. At the mesostructural level, issues of bulk creep resistance, corrosion resistance and resistance to crack formation and extension will be evaluated using precracked tension specimens and by using pressurized creep tube specimens where stresses, corrosion exposure and crack geometries can be evaluated *in situ* during exposure and deformation. The experimental program will employ a number of unique capabilities: *in situ* TEM straining experiments, 3D tomographic TEM analysis of dislocation-particle, dislocation-dislocation and dislocation-boundary interactions, *in situ* synchrotron intense x-ray analysis of bulk deformation processes, and FIB lift-off of fracture and corrosion surfaces for intensive analysis by TEM and SEM/ESBD. The micro-scale and meso-scale results will be coordinated through a major physics-based modeling effort. The results will be directed toward developing an ODS alloy structure which is highly resistant to creep and environmental attack at temperatures up to 1000C.