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Thermodynamics and kinetics of competitive crystallization pathways during devitrification of Al-Sm amorphous alloys

R.E. Napolitano¹, S.H. Zhou², F. Meng², W. Wang², P. Ray², M.J. Kramer²¹Iowa State University, USA²Ames Laboratory, USA

Amorphous alloys of Al-Sm exhibit competitive devitrification behavior upon reheating, involving competition between multiple metastable phases. These include large-unit-cell phases with cubic, hexagonal, and tetragonal symmetry, along with more conventional stable and metastable compounds of the Al_xSm variety. Phase selection during crystallization is strongly path dependent, owing to effects of non-crystalline ordering and the role of diffusion and chemical partitioning in the morphological dynamics. In this work, devitrification kinetics are investigated and quantified using high energy X-ray diffraction, thermal analysis, and electron microscopy. Measurements are related to system thermodynamics in the highly driven regime highlighting principles of selection. Growth mechanisms are investigated in detail, with particular attention to chemical partitioning associated with the initial crystallization front. Implications with respect to other Al-RE (rare-earth) systems are also discussed. This work was supported by the U.S. Department of Energy, Office of Basic Energy Science, Division of Materials Sciences and Engineering. The research was performed at the Ames Laboratory, operated for the U.S. Department of Energy by Iowa State University under Contract No. DE-AC02-07CH11358.

ren1@iastate.edu