ABSTRACT

High strength low alloy aluminum (HSLA-Al) is a minimalist alloy design paradigm under active development at Michigan Tech. The strategy follows a similar path to that which led to the development of the successful HSLA steels; that is, the removal of many generations of additive, piecemeal alloying to create less complex alloys that rely primarily on microstructural control and stabilization for property development. In effecting the “start over,” the resulting aluminum alloys provide a plethora of benefits derived from the relatively dilute, but highly engineered, alloying additions that comprise this new family of alloys.

One of the several strategies under development in the HSLA-Al area involves the addition of modest levels of solute selected for the purpose of effecting grain boundary stability. Here, solute is identified based on certain criteria that predict a propensity of the solute to diffuse to grain boundaries, and to lower the energy of the boundaries once there. In this work, dilute additions of Sr, Yb, and Sc were individually incorporated in aluminum solvent. Nano-dimensional grains were evolved using a combination of melt spinning followed by high energy ball milling. Following elevated temperature annealing treatments, the alloys remain nanocrystalline, with the efficacy of stabilization Sr > Yb > Sc. Disappearance of equilibrium intermetallic phases initially present in the XRD patterns of the Sr and Yb alloys are observed to occur coincident with the stabilization after annealing, suggesting that the stabilization is a consequence of precipitate dissolution and enrichment of boundaries with solute.

BIOSKETCH

Dr. Stephen L. Kampe is the Franklin St. John Professor and Chair of Materials Science and Engineering at Michigan Tech. In addition to his administrative responsibilities, he conducts research in areas of opportunity within the subdiscipline of physical metallurgy, with recent research activities including multifunctional metal matrix composites, aluminum alloy development, mechanical behavior characterization, and reaction synthesis processing. His teaching responsibilities have included courses on mechanical behavior, mechanical testing, composite materials, and material selection and design. Dr. Kampe has over 120 technical publications and presentations, and he holds nine patents in various aspects of innovative materials processing and composite synthesis. Prior to Michigan Tech, Dr. Kampe proudly served on the faculty of Virginia Tech for 16 years, and as a Senior Research Scientist in Martin Marietta’s corporate laboratories for six years. He is a member of TMS, ASM, and ASEE. Dr. Kampe received three degrees (B.S., M.S., and PhD) in Metallurgical Engineering from Michigan Tech.