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M3Or2A-04: Investigating the impact of tensile stress-induced/annealing-affected dislocation and grain boundary on the performance of High Purity Aluminum Wire by EBSD.

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It is essential to develop lightweight cables with low AC loss in the application of electric aviation. High Purity Aluminum (HPAL), which operates effectively at cryogenic temperature, has been developed to compete with superconductors especially in higher frequencies. HPAL, characterized by 99.999% aluminum purity, achieves a residual resistivity ratio (RRR) up to 1000. It has minimum impurities, dislocations, and defects resulting in remarkably low resistivity at cryogenic temperatures, but at the same time, the mechanical properties of HPAL itself are inadequate for practical application. HyperTech Research developed a multi-strands HPAL wire with Cu-Ni matrix and Nb barrier to provide sufficient mechanical support. However, we wish to explore the microstructure and performance of HPAL wire under strain due to tensile stress, thermal stress. In this study, we performed Electron Backscatter Diffraction (EBSD) analysis on various HPAL wires to evaluate the impact of tensile stress and annealing on density of dislocations and grain boundaries which influence RRR. The yield stress and ultimate tensile stress of the HPAL wire were first measured using a material testing system (MTS). Subsequently, we prepared three samples for tensile stress analysis: i) As received; ii) Subjected to 0.5 × yield stress; iii) Subjected to 1 × yield stress. To investigate the effects of annealing temperature, we prepared additional samples: i) No heat treatment; ii) Annealed at 200℃; iii) Annealed at 400℃. We measured the RRR of these samples and conducted EBSD analysis to characterize dislocations and grain boundaries. The results indicate that tensile stress induces dislocations, reducing the RRR of HPAL. Conversely, annealing decreases the density of dislocations and grain boundaries, leading to an increase in RRR. In addition, future study will include EBSD analysis to further investigate how cyclic stress affects dislocations and grain boundaries. This study is funded by NASA phase I SBIR

Author: Mr GUO, Yang (The Ohio State University)

Co-authors: KOVACS, Chris (Scintillating Solutions LLC); COLLINGS, Edward (The Ohio State University); Mr KWON, Jin; SUMPTION, Michael; GARG, Tushar (The Ohio State University); ZHANG, Xianhao; Dr PENG, Xuan

Presenter: Mr GUO, Yang (The Ohio State University)

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