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M1Or1C-04: High purity aluminum in cryogenic motors for electric aircraft

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Ultrahigh conductivity Al (Al hyperconductors, RRR ˜10ˆ4) can be considered as an alternative to superconductors for cryogenic AC applications e.g. in the stators of electric aircraft fan motors. Such conductors can be much better than normal state wires, and competitive with superconductors in certain frequency bands. On the other hand, the low yield strength of such a material renders a conductor difficult to manufacture and unsuitable for magnet applications. To offset the low yield strength, the pure Al can be reinforced by bonding it to a high-strength alloy. In past work, the alloys Al-8Fe4Ce (RRR ˜ 17) and Al-4Fe2Ce were selected which have the needed strength and will not contaminate the pure Al. However, an applied magnetic field to the alloy conductor can degrade the RRR to an extent quantified by anomalous magnetoresistance. In this effect, A transport current, I, is divided between the core and the sheath in the inverse ratio of their resistances; the core current is dominant and in the presence of an applied field, B, produces a Hall voltage VH which drives a current along the sheath and dissipates power. In this work, we design a high-purity aluminum strand with a high-resistivity matrix material, Cu-30Ni, and measure its contributions to anomalous magnetoresistance using PPMS temperatures down to 4K in fields up to 12T and compare its results to analytical calculations and modeling with FEM.

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