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M3Or2A-05: Impact of anomalous magnetoresistance and cyclic deformation on RR values of HPAL composites at low temperatures

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High power-density motors are required to meet demand for increasing interest in aircraft electrification. To reach these requirements high current density and lightweight conductors are required in the motor windings. With liquid cryogen on-board, low temperatures (20 K with LH2) are achievable where very high purity normal metals benefit from resistance ratio (RR) values of up to 1000. This high RR occur not only due to high purity, but also low levels of defects (including grain boundaries and dislocations). High-purity Aluminum (HPAL) is one such material where 99.999% or higher purity allows for highly competitive mass-specific amperage capacity due to high RR values at 20 K and its low mass density of 2.7 g/cm3. However, HPAL intrinsically possesses low yield and tensile strength and requires a strengthening matrix for use in applications. Previous work on HPAL multifilamentary composites successfully developed Al-alloy metal matrix to increase composite strength without degrading HPAL purity, but faced degradation in RR values in electric windings due to an anomalous magnetoresistance contribution. We demonstrate here that a higher resistivity matrix can quench this anomalous magnetoresistance. A second issue seen in previous HPAL composites was the presence of RR degradation with cycling. However, the new composite design has a higher elastic modulus in order to enable higher stress before RR degradation. In this work we measure the effect of cyclic deformation on RRR in HPAL composites at low temperatures in a new testing fixture. We correlate this with SEM and EBSD measurements.
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