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Wed-Af-Or15-04: Low loss HTS stator coils for high power density superconducting motors

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Future hybrid and all electric aircraft require superconducting electric motors and generators in order to most readily attain power densities above 10 kW/kg, preferably at operating temperatures of $>40\text{K}$. Although the rotor operates at fields of up to 5 T, because it is DC, it can be wound with HTS tapes, for example 2G, that can generate these fields at $> 40\text{K}$. The stator, however, operates in AC mode, for example, 0.5 T at 200 Hz, making it problematic to use tapes due to their high losses in ac fields, requiring instead, HTS as small cross-sectioned, fine-filament wires that are cabled into low-loss transposed forms. Due the challenges of attaining low AC loss with tapes, HTS usage for stators has not been an option. Recent advances however with our high performance, strong HTS 2212 wire, now enabled development of first of their kind HTS cables with loss reducing features and configurations specifically designed for HTS stators operating at 40 K or greater. As a first step, small diameter, high current density 2212 wires have been developed with features required for low ac loss, including non merged, small sized filaments, short pitch length axial twist and increased resistance between filaments. These wires were then used to develop and build prototype high current cables, followed by fabrication of stator-type test coils that demonstrated the feasibility of building HTS stator coils with 2212. A design analysis with 2212 stator coils showed several promising options for building high power density, high efficiency all HTS motors that operate at 40 K or greater.

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