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M1Or3G-05: [Invited] Applications for additive materials in superconducting motors

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Superconducting electric motors offer the potential for low weight and high power in applications such as electric aircraft and high speed marine transport. Combined with renewably-sourced cryogenic fuels and advanced fuel cells they offer a path to zero-carbon mass transport. The proposed architectures of these extreme machines, operating at temperatures around 20K to 50K and employing very high alternating magnetic fields, require materials for the stator that are not electrically conducting and at the same time have good cryogenic structural performance.

Additively manufactured polymers can play a key role in these designs, and a collaboration between the Robinson Research Institute and AUT is studying the performance of a range of composite polymers in superconducting machine applications. There are significant challenges to be met, including understanding the effect of the build process on material properties at low temperatures, and also the effect of formulation changes on thermal properties.

Additively manufactured metals can be employed in the rotor components, where the magnetic field fluctuations are very small for our synchronous designs. In this usage case, we can achieve dramatic reductions in the weight of the rotor assembly by minimising the number of joints and facilitating the design of multi-functional components in our helium cooled, vacuum cryostat architecture.

The performance requirements for a number of key components in our prototype machines are discussed along with cryogenic testing results for selected additively manufactured materials and composites.

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