Pulsed Field Magnetization of Superconducting Tape Stacks for Motor Applications

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Abstract — The potential of (RE)BCO superconducting bulks in rotating machine designs has been explored through numerous experimental prototypes with the bulks being magnetized to act as field poles. The pulsed field method of magnetization has emerged as one of the most promising due to its low cost and practicality. However, problems with heating in the bulks have led to the creation of thermally stable composite bulks made of a stack of coated conductor. Containing less than 2 % superconductor by volume, field cooling and pulsed field magnetization tests have shown the enormous potential of these stacks to trap magnetic fields higher than bulk superconductors without being more expensive. The results reported will build on previous records set by the present authors for 12 mm square stacks (2 T for using pulsed fields [1] and over 7 T for field cooling two stacks [2]) with a focus on motor applications. The benefits of using a stack of tapes as field poles will be explored. The ability to have a long rectangular stack allows for motor designs with more efficient field poles in terms of flux produced per unit area of the pole as well as easy scalability. Such a rectangular pole could be magnetized by a racetrack pulsed field coil for which modelling will be reported. The first ever experimental pulsed magnetization of rectangular stacks will also be reported for a temperature range of 10 – 77 K using a fully automated pulsed magnetization system as well as a summary of trapped field results using tape from a number of different coated conductor manufacturers. The software automation is applicable to prototype motors. Flux creep of trapped field in bulks and stacks of tape is a major concern for rotating machine applications. Experimental results will be reported proving that by cooling the stacks below the lowest magnetization temperature, flux creep can be reduced to less than 0.1 % in 48 hours. Unlike bulk superconductors, supercurrent in a stack of tapes can only flow in planes perpendicular to the axis which means that cross-fields present due to rotation in a machine would not induce as much unwanted supercurrent as suggested by modelling which is another attractive property.

[1] Patel A, Hopkins S C and Glowacki B A 2013 Supercond. Sci. Technol. 26 032001 (IOP Fast Track Communication)
[2] Patel A, Filar K, Nizhankovskii V I, Hopkins S C, Glowacki B A 2013 Appl. Phys. Lett. 102 102601

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