Experimental Results and Finite Element Analysis of Single REBCO Tape and TSTC Cable for High field Magnets

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***Abstract*—Second generation high temperature superconducting (HTS) tapes have great mechanical properties as well as excellent high current and high field capabilities. These characteristics make them a very promising conductor for applications like accelerator and fusion magnets. Several HTS tape cabling methods are under development for these magnet applications. To improve fabrication methods and maximize operational performance of these cables composed of several HTS tapes, it is necessary to characterize both the electromechanical behavior of the full scale cables and of the individual tapes under anticipated thermal, mechanical and electromagnetic loads.**

In this talk we will present laboratory experimentation and structural finite element analysis (FEA) that have been used to investigate the electromechanical behavior of single HTS tapes and TSTC conductors. Experiments were conducted to evaluate critical current performance, under various loads while finite element analysis was used to analyze the strain dependence of that critical current for each load type.

Single tape experiments were conducted on commercially available HTS tapes under transverse compression (wide face and thin edge), pure torsion, axial tension and combined tension-torsion loads. The single HTS tapes were also analyzed under the same loading conditions using structural finite element analysis. A novel technique was developed for modeling the layered composite structure of the HTS tapes using structural solid-shell elements. The numerical model was able to closely replicate the experimental stress-strain curves and torque behavior of each type of tape. The simulations also produced detailed axial strain results which were successfully paired with an analytical model to predict the critical current performance of the tapes. The numerically predicted critical current was found to have close agreement with the experimental results for each load type.

In addition to the single tape work, recent experimental results on the twisted stacked-tape cable (TSTC) are discussed and preliminary FEA analysis of the electromagnetic loads experienced in high field magnets are also presented.

The numerical and experimental results discussed in this work, provided important details about the strain dependence of the critical current for various load types expected during high field magnet operations.

***Keywords, Index Terms*—REBCO, Twisted Stacked-Tape Cable (TSTC) Conductor, finite element analysis, electromechanical loads.**

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