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High-speed thermal imaging of quench propagation in HTS tapes using temperature-sensitive fluorescent films

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The Normal Zone Propagation Velocity (NZPV) and quench are areas of intense research for High Temperature Superconductors (HTS). While normal zones travel with speeds in the order of magnitude of m/s in Low Temperature Superconductors (LTS), in HTS coated conductors this speed is in the order of cm/s. This makes ensuring a quick and uniform quench, and thereby the cryostability of tapes, challenging. Such slow NZPV can lead to excessive local heating and hotspots in applications such as cables and magnets, leading to the destruction of the equipment. To develop new HTS tape manufacturing techniques and architectures that help increase the NZPV a reliable measurement method is needed for evaluating the merits of these technologies. In this work a new optical method is presented for thermal imaging and measurement of quench propagation and NZPV in HTS tapes. The novelty of the method is that it allows mapping the temperature distribution on a 2-D surface, in real time. The technique is based on the temperature dependent light emission of a rare-earth fluorophore in conjunction with a high-speed camera, capable of recording the fluorescence at 2500 frames per second. Together these allow for direct observation of dynamic events, such as the quench, in the time domain of milliseconds. Using the light intensity of each pixel in the recording and adequate post-processing steps allow for the extraction of thermal data. Hence the measurements serve with both qualitative and quantitative temperature information, which can be used to compare quench behaviour of various tapes and architectures. This work shows a proof of concept of the developed method together with preliminary results of quench propagation measurements in silver stabilized HTS tapes.

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