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Method of Manufacturing Fast Ramping Non-Insulated HTS Pancake Coils

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HTS is valuable for future detector magnets as it allows operation at elevated temperatures and magnetic fields. However, due to slow propagation of normal-zones, quench protection remains a challenge. Non-insulated coil technology offers a potential way forward, but controlling the associated ramping time constant is still an unresolved challenge. This study offers a potential way to have non-insulated coil technology with a desirable low time constant.

The radial resistance of a no-insulation pancake coil depends on many factors. The most important factors are the thickness of copper stabilizer, the thickness of the substrate and if- or if not the turns of the coil are soldered together. The oxide buffer layers between the substrate and ReBCO layer are insulators in bulk and have a high resistance as thin layers. Consequently, the path with the lowest resistance from one turn to the next turn is through the copper channels on the edges of the tapes. This bypass provides a low resistance passage in case of quench, but it increases the practical ramp-time of such coils drastically. A compromise can be made between the added protection and the ramp-time by fully soldering the coil pack and afterwards physically removing the copper and solder channels on the sides of the tapes. Now, the radial turn-to-turn resistance is dominated by the resistance of the substrate and buffer layers, which significantly reduces the time constant.

Three compact ReBCO HTS pancake coils were prepared using this preparation technique. Their time constants were reduced by a factor of 500 from around one hundred seconds to only a few hundred milliseconds by removing these copper channels. Tests were performed both in LN2 and in vacuum in a temperature range of 55 to 80 K. An overview of the preparation procedure, demonstrator coils and the test results will be presented.

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