# High Temperature Superconducting Tape with a Current Flow Diverter Architecture for Current Flow Limitation in a High Voltage Direct Current Grid

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***Abstract*—Superconductor fault current limiters (SFCLs) are considered as one of the most promising applications of REBCO tapes. While actual commercial REBCO tapes are suitable for designing SFCL for medium-voltage network (50 kV/m fault lasting 50 ms), it is necessary to increase the electric field of REBCO tapes under limitation (up to 150 V/m) in order to implement a SFCL that can be used in an HVDC grid (voltage above 300 kV) that is not excessive in terms of size and cost. The H2020 European project FASTGRID aims at developing the best conductor design to fulfill these requirements.**

**At present time, commercial REBCO tapes possess local critical current densities Ic that vary along their length (approximately +/- 20% of variation). This variation is inherent to the fabrication process. In the case of a prospective fault current that corresponds to the minimum local Ic of the tape, only a small zone will quench (called "hot spot"). Considering the low normal zone propagation velocity (NZPV) of commercial REBCO tapes, a local destruction of the tape at the hot spot location thus becomes very likely.**

**Besides increasing the homogeneity of Ic by improving the fabrication process, another solution to mitigate the hot spot issue is to homogenize the quench by increasing the NZPV of REBCO tapes. A promising way to increase the NZPV is the so-called current flow diverter (CFD) concept. In the CFD concept, a highly resistive layer that partially covers the HTS-Ag interface is added which forces the current to pass by the edges of the REBCO tape. Another solution to increase the NZPV is to use a flexible sapphire substrate. In comparison to Hastelloy, sapphire possesses a high thermal diffusivity.**

**In this work, we have performed numerical simulations using a commercial finite-element software to investigate the influence of various combination of shunt (Hastelloy, stainless steel, composite and silver) and substrate (Hastelloy and sapphire) whose thicknesses vary from 0 to 500 microns on the NZPV of a REBCO tape with a CFD architecture. Our results indicate that in the case of a non-conductive shunt, the CFD architecture increases the NZPV by one order of magnitude regardless of the thickness of the shunt or the type of substrate. Our results also indicate that the use of a thick conductive shunt in combination with the CFD architecture reduces the gain in NZPV. In conclusion, our numerical simulations suggest that the combination of a thick high-Cp non-conductive shunt and the CFD architecture maximize the chances of finding a REBCO tape architecture able to withstand both a clear fault (150 V/m for 50 ms) and a prospective fault equal to the minimum local Ic of the REBCO tape. Putting aside the processing issues, it is thus the best theoretical REBCO tape design for a SFCL to be used in an HVDC grid.**

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