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Bulk based technologies

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Recent years have seen a tremendous progress in fundamental understanding of physical mechanisms limiting the performance of superconducting radio frequency (SRF) cavities, enabled by implementation of new research techniques, and exploring new materials such as Nb3Sn.

Accelerating gradient limit of SRF cavities both of Nb and Nb3Sn was shown to be higher than Hc1, providing a tantalizing outlook for the upcoming years. Fermilab's Nb3Sn program has been started and is proceeding forward at the fast pace.

Components of surface resistance (which determines the value of Q0) and their RF field dependence for niobium cavities prepared by different state-of-the-art techniques have been measured and thoroughly analyzed within the context of BCS-based theory in an unprecedented range from milliVolts/m to > 30 MV/m, shedding light on all the so-called Q-slopes.

Fundamental materials science uncovered previously unknown contributors to both the surface resistance and achievable gradients, such as nanoscale niobium nanohydrides, which gain superconductivity only by proximity effect.

In this contribution I will review these recent breakthroughs and outline a possible stream of further advancements stemming from them, which may happen on the timescale of relevance to FCC, and may shape the emerging research program in this area.

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