

Quality degradation of niobium rf cavities due to hydrogen contamination—the Q virus

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Superconducting niobium cavities can achieve quality (Q) factors of 10^{10} – 10^{11} , more than six orders of magnitude higher than conventional copper cavities. However, to maintain this performance at high accelerating gradient (20 MV/m), the rf surface must be damage and dust free. Cavity preparation techniques routinely include a chemical etch or electropolishing. Under certain conditions, these treatments can contaminate the niobium with hydrogen. If the hydrogen concentration exceeds 2 wt.ppm., hydrides may form when the cavity is cooled through 150 K, thereby reducing the cavity quality substantially (Q virus). A rapid cooldown can inhibit the hydride formation. Other “cures” include degassing cavities at 900 C to eliminate the hydrogen.

Presented here is an overview of the preparation and handling of superconducting rf cavities, the conditions that may lead to the Q virus, and a qualitative explanation of the mechanism. Techniques to cure or at least avoid the manifestation of the Q degradation are also covered.