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Enhancement of medium-temperature heat-treated SRF cavities for high quality and high gradient

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The heat treatment of SRF cavities at medium temperature (250°C to 350°C), also known as “mid-T heat treatment”, is one of the R&D activities at DESY towards a high-duty-cycle (HDC) upgrade of the European XFEL.

Such treated cavities exhibit an improvement in the quality factor Q_0 ($3 \cdot 10^{10}$ to $5 \cdot 10^{10}$) at a moderate accelerating electric field strength E_{acc} (10 MV/m to 20 MV/m) compared to EuXFEL cavities. In fact, cavities treated in this way do experience quenching at E_{acc} in the range of 20–30 MV/m, i.e. they cannot be operated at gradients above 30 MV/m.

However, in this work, we have found that a heat treatment consisting of a combination of mid-T and low-T not only favorable high Q_0 -values were measured, but additionally high gradients of up to 40 MV/m could be achieved. This offers great potential for upgrading modern LINACs with new high usable performance.

The results of 1.3 GHz TESLA-type single- and nine-cell cavities as well as the influence of the effective oxygen diffusion length l will be presented. Further insights into the surface of Nb are provided by supporting sample analyses.

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