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# Nb3Sn growth on niobium in vapor diffusion process and its application to large RF surface

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Nb3Sn-coated SRF cavities can potentially achieve superior performance in terms of quality factor, accelerating gradient, and operating temperature. Tin vapor diffusion process of Nb3Sn coating on Nb is a simple, yet efficacious technique to fabricate Nb3Sn-coated SRF cavities. The process comprises two¬ steps: "nucleation" followed by "deposition". The crucible with Sn/SnCl2 and the substrate at a constant temperature of about 500 ℃ for several hours is the "nucleation"; the crucible and the substrate at a constant temperature, typically, above 1000 ℃ is the "deposition"step. Using custom-built sample coating chamber, we have coated over a hundred samples to systematically study the vapor diffusion process under varying process conditions and at different stages of the coating process. The surfaces, thus obtained, were investigated with surface studies techniques, such as SEM/EDS, AFM, XPS, SAM, SIMS, EBSD and TEM. Based on the experimental results, we will discuss nucleation and growth of Nb3Sn coating during vapor diffusion process
Translating small sample coatings to large surface areas presents a number of challenges. Processes typically must be modified to provide coating conditions in different areas adequate for the desired film growth. Besides process development challenges, large surface areas are more likely to host defects, which compromise film growth. Recently we started coating CEBAF 5-cell cavities to study and develop Nb3Sn vapor diffusion process for larger structures. Coated cavities were visually inspected and, in some case, RF tested at cryogenic temperatures. Samples coated along with the cavities were studied with surface studies techniques. Process evolution and the current understanding of the film growth and its limitations on such substrate will be discussed.

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