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Nb3Sn thin films for dark matter detection

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Nb3Sn has great potential to be the next generation superconducting material on the inside of Cu superconducting radiofrequency cavities (SRF) due to its relatively high critical temperature Tc ≈ 18 K compared to other low temperature superconductors e.g., Nb with Tc ≈ 9 K. For Axion detection, cavities might operate below 100 mK, and copper bodies are preferred. Here, we report methods to make Nb3Sn films on copper substrates that could be scaled to microwave detectors. We develop bronze routes to facilitate a Nb-Sn reaction at ˜700 ℃, well below the melting point of Cu. We use Ta as a diffusion barrier and possible mitigation of thermal contraction mismatch. High Sn activity is obtained by using Cu25at.%Sn (epsilon phase) instead of alpha-bronze as our Sn source. We then explored formation of Nb3Sn via reaction of the multilayer Cu substrate/barrier/Nb/bronze at >700 ℃. Cross-sectional SEM/FIB analyses were performed to see the differences in morphology and composition of the films. Since copper was the dominant material, thermal contraction applied stress to the resulting Nb3Sn films reducing Tc to ˜15 K. We also designed, modeled, and machined a cavity to test the RF properties of our thin films.

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Yes

Footnotes

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