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Diffusion and acoustic properties of Nb thin films studied by time-domain thermoreflectance

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The thermal diffusion and acoustic properties of Nb impacts the thermal management of devices incorporating Nb thin films such as superconducting radiofrequency (SRF) cavities and superconducting high-speed electronic devices. The diffusion and acoustic properties of 200-800 nm thick Nb films deposited on Cu substrates were investigated using time-domain thermoreflectance (TDTR). The films were examined by X-ray diffraction, scanning electron microscopy, and atomic force microscopy. The grain size and thermal diffusivity increase with film thickness. The thermal diffusivity increased from 0.100± 0.002 cm2s-1 to 0.237± 0.002 cm2s-1 with the increase in film thickness from 200 nm (grain size 20±6 nm) to 800 nm (grain size 65±16 nm). Damped periodic photoacoustic signals are detected due to laser heating generated stress in the Nb film, which results in an acoustic pulse bouncing from the Nb/Cu and the Nb/vacuum interfaces. The period of the acoustic oscillation gives a longitudinal sound velocity of 3637.3 ms-1 inside the Nb films, which is in good agreement with the values reported in the literature.

Footnotes

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