

8 - 12 Laser Annealed Copper-based Nb and Nb₃Sn Films

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Laser annealing of copper-based Nb and copper-based Nb₃Sn thin films was studied in detail by the RF Surface Technology Group in 2022. The RF performance of copper-based Nb and copper-based Nb₃Sn thin film cavities is largely limited by surface defects, which can be eliminated by annealing. Compared with conventional annealing, the heat affected zone of the laser is shallow and it allows annealing to micrometer depth without affecting the copper substrate while eliminating surface defects in Nb and Nb₃Sn thin film.

We have calculated the heat-affected zone about laser annealing of copper-based niobium films. As shown in Fig. 1, the results show laser heat-affected zone depth is 0.7 μm and the theoretically estimated recrystallization temperature zone is within 0.2 μm, proving that laser is fully capable of annealing copper-based niobium films without affecting the copper substrate. The follow-up experimental data are in good agreement with the simulation results, which is a very important guideline for future RF superconducting cavity annealing.

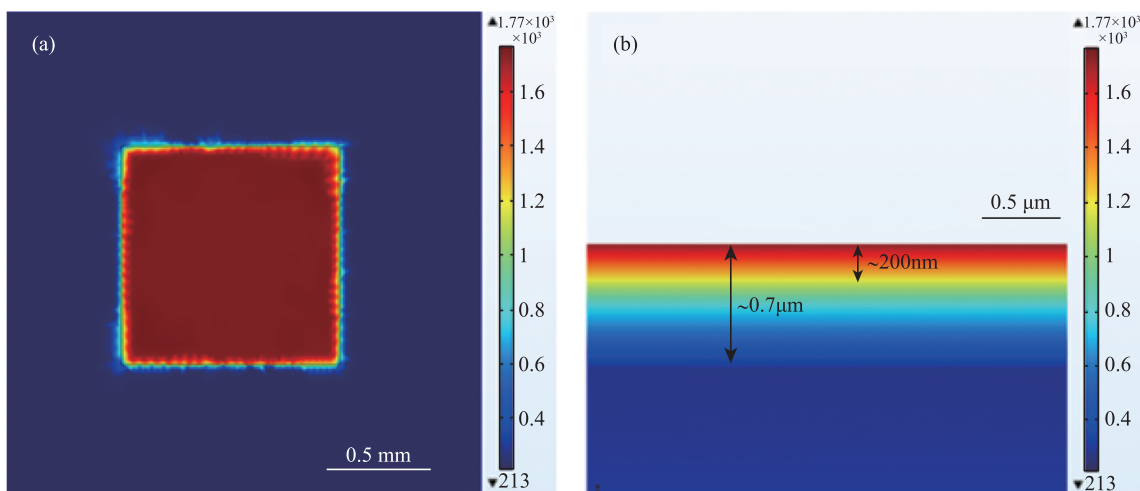


Fig. 1 (color online) Temperature field simulation results of copper-based Nb thin film, energy density 10 mJ/mm², pulse width 10 ns, frequency 25 kHz, single pulse.

We have laser annealed copper-based Nb₃Sn films using different laser parameters. Results in Fig. 2 showed that the surface defects of Nb₃Sn were significantly reduced at suitable laser parameters. In addition, the film adhesion was improved. The study initially confirmed the feasibility of laser annealing copper-based Nb₃Sn, and as the study continues, this method will be subsequently applied to the whole cavity post-treatment of Nb₃Sn thin-film cavities, which is of great significance for Nb₃Sn thin-film cavities.

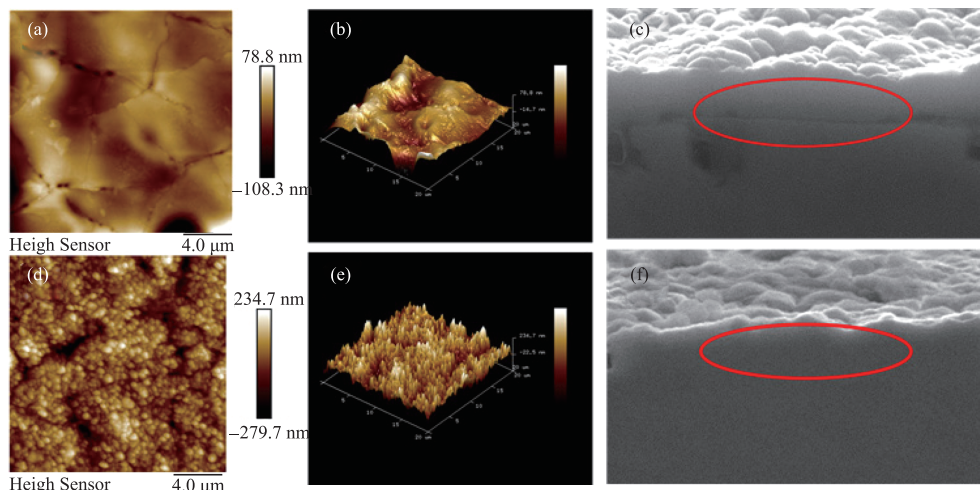


Fig. 2 (color online) Characterization of Nb₃Sn, (a)(b)(c) AFM and SEM of unprocessed sample, (d)(e)(f) AFM and SEM of processed sample.