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Evaluation of LASER ablated surface engineering of copper and stainless steel for particle accelerators

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The reduction of secondary electron yield (SEY) is a very effective way of mitigation of electron cloud (e-cloud) and beam induced electron multipacting in accelerator beam chambers and RF wave guides. During the past five years it has been shown that Laser Ablation Surface Engineering (LASE) is very effective method to reduce SEY well below one. Furthermore, it was shown that the reduction of the SEY is due to creation of hierarchy of structures generated during the laser ablation, these structures are very effective to trap the emitted secondary electron within the surface by multiple scattering and most efficient for the low energy electron. To enable an application of LASE for accelerator beam chamber a number of questions has been addressed in ASTeC.

The LASE beam chamber must be vacuum compatible. The difference in thermal outgassing between the LASE treated and non-treated samples is below the sensitivity limit. The electron stimulated desorption (ESD) study has been conducted to compare the LASE treated and non-treated stainless steel and copper samples. Particulate generation can be controlled. The LASE surface does not require any cleaning after the laser processing; however, if it has been contaminated, it can be cleaned with vacuum cleaning solvent and in ultrasonic bath, but it may lead to some increase in SEY.

The presence of LASE structures at the surface may increase the surface resistance, which can lead to increased beam impedance and energy spread as well as to an increase in the heat load budget at cryogenic beam chamber. Hence, it is essential to accurately determine the surface resistance after laser surface treatment. High conducting oxygen free (HCOF) copper and stainless steel samples were irradiated with infrared laser at different repetition rates and power to produce different surface structure. This has produced different surface structure with various SEY. The surface resistance of these surfaces is measured using cylindrical symmetric resonator, which can generate surface currents in the samples whose surface resistance can be determined from the resonator's quality factor.

A correlation between laser parameter, induced surface structure, ESD, SEY and surface resistance will be reported.

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