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Effect of power on laser cleaning result of stainless steel surface

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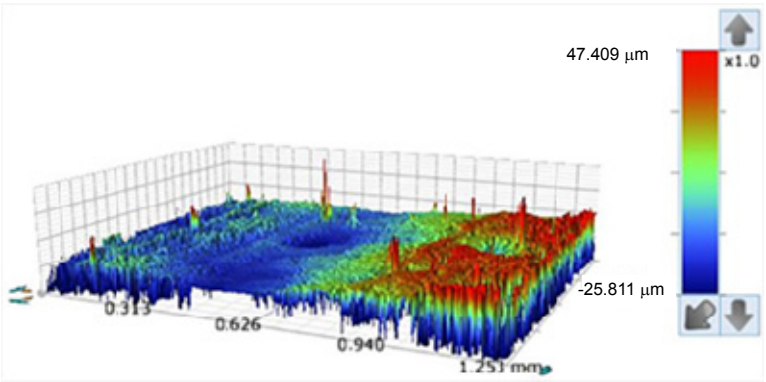

3D Profile of 304 stainless steel sample after laser cleaning.

Abstract: Laser cleaning has been widely used in many industrial fields because of its high efficiency and no second waste. From this point of view, laser cleaning has promising applications for removal of corroded layer in stainless steel pipe in nuclear plants, compared with conventional chemical and mechanical methods. In this work, systematic laser cleaning experiment of oxide on stainless steel was conducted, and the effect of different laser power (300 W, 400 W, 500 W) on cleaning effect was studied, which obtained the optimum processing parameters on this account. The surface morphology and composition distribution of stainless steel are analyzed by SEM and EDS before and after laser cleaning. The surface roughness was measured by white light interferometer and the removal thickness of oxide was evaluated by the sectional step height. The main results show that: 1) the oxide of stainless steel decomposes and flakes gradually with the increase of power, and the substrate is partly damaged while power exceeds 400 W. The amount of oxide increases instead at 500 W, because high power can cause laser ablation, resulting in a serious oxidation of the matrix; the content of element is mainly O and Fe at 300 W, and then the content of Cr increases continuously and is consistent with that of substrate finally; 2) The cleaning removal thickness increases from 17 μm to 50 μm with laser power; 3) The roughness value R_a is 3.44 μm before laser cleaning, while the roughness value decreases firstly and then increases, and reaches a minimum value of 0.38 μm at 400 W after cleaning; 4) The cleaning force produced by laser cleaning is the key to decontamination. Power density is the concrete data representation of cleaning force. The value of cleaning threshold and damage threshold is obtained by combining power density and experimental analysis. In order to get more accurate data, the experiments of other power (250 W, 280 W, 350 W, and 380 W) are carried out as supplementary. The oxide of stainless steel begins to expand and peel off under a 280 W laser, thus the cleaning threshold is approximately equal to the power density at this point, which is 3.96×10^3 W/cm^2.The laser cleaning starts to touching substrate and causes some damage to it when the power increases to 380 W, which is similar to that of 400 W. Therefore, the average power density of 380 W and 400 W is determined as the damage threshold, and the specific value is 5.52×10^3 W/cm^2. While the power is about 400 W, frequency is 10 kHz, speed is 30 °/h, scan frequency is 5 times, and the laser cleaning obtains the best effect after comprehensive comparison and analysis.

Keywords: laser cleaning; stainless steel oxide layer; laser power; roughness; cleaning thickness
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