Blackening Effect in an Implant Steel by Ultrashort Laser Pulses

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ABSTRACT

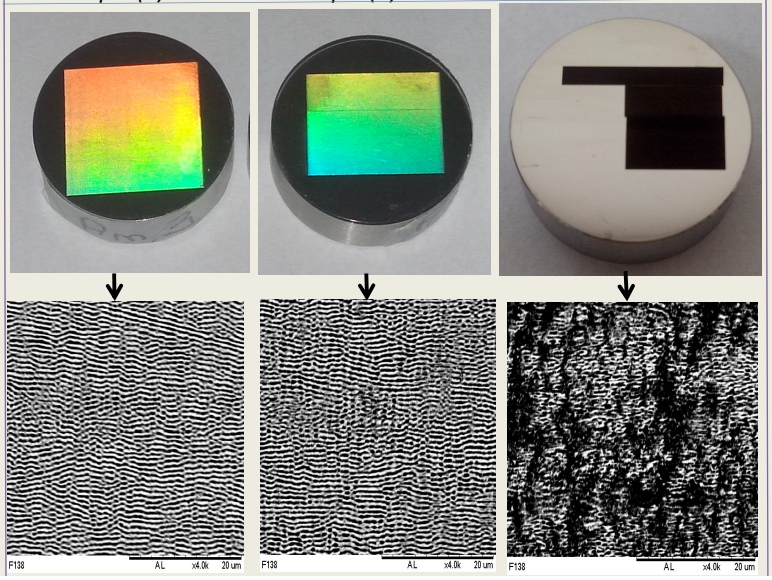
In this work, we studied the possibility of turning black the surface of an ASTM F138 stainless steel sample after irradiation by femtosecond laser pulses. The irradiations were performed varying the number N of laser pulse overlapped. After irradiation there was a visible change in coloration of the samples, which became darker as we increase the overlap rate. Employing this technique is a considerable way to produce high contrast markings without any changes in the metal microstructure, neither the formation of oxides coatings, which is important for a material with the level of accuracy required by this kind of implant

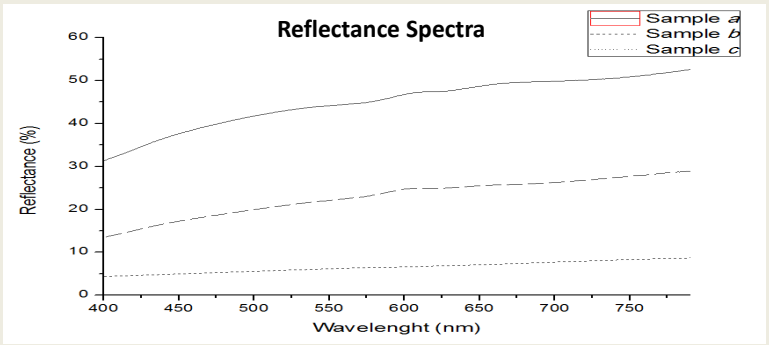
EXPERIMENTAL PROCEDURE

The experiment were conducted using a Ti:Sapphire laser system. The pulse energy was fixed in 1 µJ per pulse with duration of 30 fs. The central wavelength of 800 nm with a repetition rate of 4 kHz was set. The beam was focused through a 50 mm focal length lens. The ASTM F138 steel was obtained from a 30 mm diameter bar, a cross section was cut with 10 mm thick and its surface was grinded and polished. The polished steel was coupled to a motorized, programmable CNC system with 0.001 mm resolution. The experiments were performed by creating rectangles with different overlapped rate. The sample (*a)* was irradiated with N=4, in the sample (*b)* N=10 and the sample (*c)* N=144.

RESULTS

Sample (a): N=4 *Sample (b): N=10* *Sample (c): N=144*





CONCLUSIONS

In summary, it was possible to create a high contrast black surface by laser irradiation. Besides the black surface, it was created colored surfaces similar with the surfaces showed in [1]. The characterization of irradiated area shows that the pattern of LIPSS is dependent on the overlapping pulse rate and in high overlap rates the LIPSS became coarser and worked as a trap for the incident light causing the effect of metal blackening [2]. As expected, it was not seen oxide formation above the surface of the material, this was due the physical mechanism that create nanostructures with negligible heat of the material [3].

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