LASER INDUCED ARTIFICIAL FULGURITES FORMATION: PRELIMINARY RESULTS.

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Introduction: Fulgurites are glassy irregular tubes produced by the fusion of soil, which has been struck by lightning. The formation of a fulgurite occurs during the rapid transfer of lightning energy to a narrow channel in the ground [1, 2].

Artificial building materials are made from siliceous sand, calcite and ferrous materials from the same origin that the soil where fulgurites are formed.

IR lasers are an adequate tool to supply onto a limited area of a surface controlled thermal energy. The interaction of CO_2 lasers pulses with the surface material induces ablation and under specific conditions it could produce also structural transformations and crystallization on the surface material [3].

Raman spectroscopy is a non-destructive analytical technique that has been used to study a wide range of glassy silicate materials. Those materials are characterized by a number of broad bands that reflect the framework of the silicate structures [4, 5].

Aim: The main objective of this work is to study the formation of fulgurites in artificial building materials irradiated with CO_2 laser radiation

Methodology: Samples of 1x1x6 cm of the mortar were exposed to CW CO_2 (Synrad Firestar t80) laser radiation at different powers (8W and 40W) and different times (5 and 30 seconds).

Optical Emission Spectroscopy (OES) was used to analize the composition of the plasma plume.

After the exposure time, samples were studied by Raman spectroscopy. Raman spectra were recorded with a confocal Raman microscope (Renishaw RM2000) equipped with a 514-nm laser, a Leica microscope, and a thermoelectrically cooled CCD camera. The spectra shown were obtained with a 50× objective lens. The laser output was 100 mW, and the exposure time 10s. The area where vibration modes are found, i.e. 4000–100 cm−1, was the spectral region scanned.

Results: Figure 1 shows the aspect of the sample under CO_2 laser radiation showing the glassy fulgurite formed after irradiation. The size of the spot is bigger when higher power radiation. For the same power radiation longer time exposure produce bigger spot.

Raman spectra of the artificial fulgurite is showed in Figure 2. The presence of crystalline quartz (464; 355 and 210 cm^{-1} band) as well as several small broad bands from different Si-O bonds can be observed. When 50% of the laser power irradiated the sample, no quartz was observed; however a small band at 965 cm^{-1} indicate the presence of Si_2O_7 groups. The surface temperature reached at different conditions of irradiation were measured from emission spectra and it range from 4000 K to 5000 K.

Conclusions: For the first time fulgurites formation from an artificial building materials from CO_2 laser radiation has been studied.

Figure 1. Image of artificial fulgurite; left: irradiated 5s at 8W; middle: irradiated 30s at 8W and right: irradiated 5s at 40W

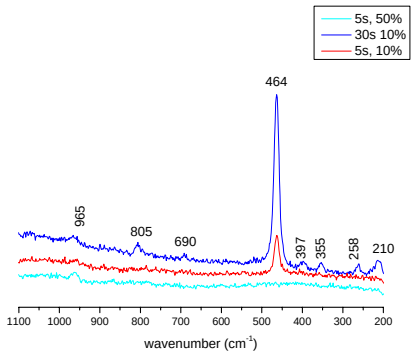

Figure 2. Raman Spectra of artificial fulgurite

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