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Formation of a Periodic Wave Structure on the Dry Surface of a Solid by TEA-CO_2-Laser Pulses

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Abstract. The formation of periodic wave patterns on surfaces of insulators and metals by means of TEA-CO_2-laser pulses was observed. The wavelength of the patterns equals that of the laser radiation. The phenomenon is illustrated by samples of quartz glass and copper.

Index Headings: TEA-CO_2-laser – Laser interactions with solids – Laser-induced surface structure

We studied the interaction of 10.6 μ TEA-CO_2-laser pulses (half-width: ≈ 150 ns and peak power: ≈ 2 MW) with various solids and observed the formation of a periodic wave pattern on the dry surface. The experiments were performed by focussing the laser beam with a Ge lens of 20-cm focal length onto the sample, yielding an intensity of approximately 10 GW/cm^2. The wavelength of

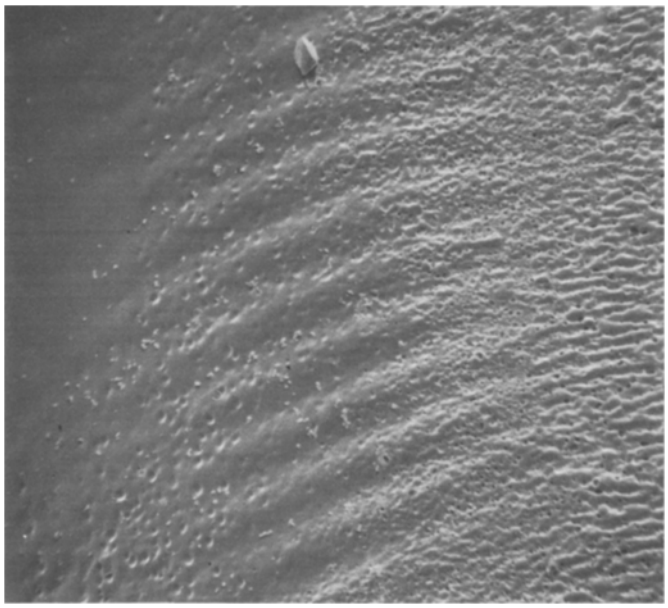

Fig. 1

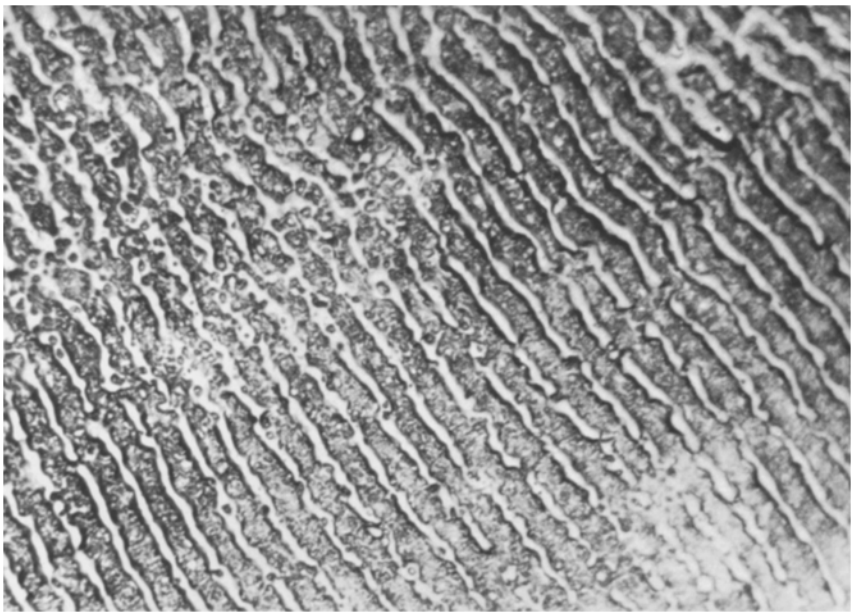

Fig. 2

the periodic surface structure seen on the samples corresponds to the wavelength of the laser radiation, namely 10.6 μ.

The appearance of this structure strongly depends on the experimental conditions, e.g. on the thermal diffusivity and the melting temperature of the solid, and on the number of pulses. It should be noticed that the effect can be observed with insulators as well as with metals. The phenomenon is illustrated with a sample of quartz glass in Fig. 1 and one of copper in Fig. 2. The pictures were taken by a scanning electron microscope (Stereoscan MK II A, Cambridge Scientific Instruments, Ltd.).

Fig. 1 shows the periodic pattern on the rim of a crater with a diameter of 0.8 mm, caused by the TEA-CO_2-laser pulses on quartz glass. Occasionally the pattern was also found inside the crater.

The surface structure on copper is demonstrated in Fig. 2. The copper is molten by the laser-beam in zones confined to the wavecrests 10.6 μ apart.

The nature of the patterns seen on those solids and others, such as glass and Armco iron, indicates thermal processes. Recalling the wavelength of 10.6 μ we infer from this observation that those patterns are due to interference of the laser radiation on the solid surface.

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