Possibility of fabricating tetragonal periodic surface structures using circularly-polarized laser pulses

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Laser induced periodic surface structures (LIPSS) is attracting interests as a versatile method to make functional surfaces. When linearly-polarized laser pulses were used, usually linear periodic structure consists of ridges and grooves are fabricated. The fabricated periodic structures are usually not perfect; ridges (grooves) have curves and branches. There are some articles on the methods for fabricating highly regular periodic structures using laser interference [1], or ultraprecision mechanical cutting [2], or by precisely choosing the laser and scanning parameters [3].

When circularly-polarized laser pulses were used, usually hexagonal lattice-like periodic structures are fabricated [4,5], but they are lacking in long-range order. Only short-range order exists. To our knowledge, there have been no articles on the methods to fabricate periodic structures with long-range order and to control lattice pattern with circularly polarized laser pulses.

Here we report that sometimes *tetragonal* periodic surface structures are fabricated on the surface of stainless steel irradiated by circularly-polarized femtosecond laser pulses. Figure 1 shows an SEM image of such a surface. As seen, there is a region (indicted by dashed yellow rectangle) where tetragonal lattice-like periodicity can be seen. The period was about 0.95 μm. The laser used was a Yb:KGW femtosecond laser (Pharos; Light Conversion) operating at 1030 nm. The laser pulses were converted to circular-polarization, and irradiated on to the sample with galvano-mirror scanning. We are trying to identify the condition under which regular tetragonal lattice is fabricated, also to fabricate large-area tetragonal structures.

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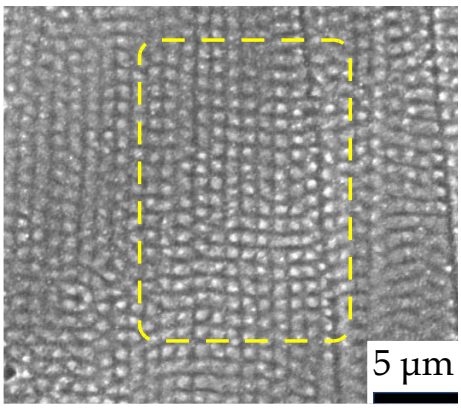

Figure 1: SEM image of the surface of stainless steel irradiated with femtosecond laser pulses.