Laser-induced periodic surface structures on titanium alloy and zirconia ceramics formed by irradiation of femtosecond two-color double-pulse sequences

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Titanium alloy and zirconia ceramics (3Y-TZP) are commonly used for medical implants because of their high-mechanical property and biocompatibility. We have observed fs-laser-induced periodic surface structure (LIPSS) on 3Y-TZP [1] and confirmed positive effects on medical implant[2]. To investigate the mechanism of LIPSS formation, we have carried out one-color double-pulse irradiation experiments [3]. In this study, we report two-color double-pulse irradiation[4] on titanium alloy and 3Y-TZP with controlling polarization.
Laser pulses from a Ti:sapphire laser system (800 nm, 130 fs FWHM, 1kHz) were directed to a interferometer for generating a two-color cross-polarized double-pulse sequence [5]. The delay τ was adjusted in a range of -100 ps $\leq \tau \leq$ +100 ps. Forty two-color double-pulse sequences were irradiated onto sample with the polarization states controlled by an achromatic quarter-wave plate (QWP) as shown in Fig.1 .

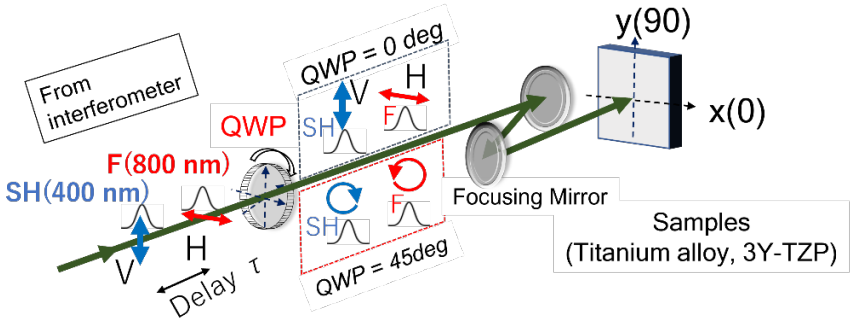

Figure 1: Two-color double-pulse irradiation setup with controlling polarization states.

For 3Y-TZP, it was found that the polarization of the first arriving pulse played an important role for LIPSS formation. For titanium alloy, two kinds of LIPSS, the LSFL (low-spatial frequency LIPSS) and the HSFL (high-spatial frequency LIPSS) for two colors, and their combinations were observed depending on the fluences and delay. Spatial variation of the fluence due to the Gaussian beam results in complicated LIPSS patterns.

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