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Author: Zhilin Xia Cheng Chen Hong Fang Shi Chen

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The mechanism and process of nanosecond pulsed-laser induced subwavelength periodic ripples on silica films

Zhilin Xia[1, 2, *], Cheng Chen[1], Hong Fang[1] and Shi Chen[3,]**

[1] *School of Materials Science and Engineering, Wuhan University of Technology, Wuhan, Hubei 430070, China*

[2] *State Key Laboratory of Silicate Materials for Architectures, Wuhan University of Technology, Wuhan, Hubei 430070, China*

[3] *School of information engineering, Wuhan University of Technology, Wuhan, Hubei 430070, China*

Abstract: The discovery of subwavelength periodic ripples with similar grating structures is currently mainly associated with femto-/picosecond laser ablation experiments. A nanosecond laser is generally accepted as incapable of etching subwavelength periodic ripples. Recently, the subwavelength periodic ripples on the surface of silica films induced by nanosecond laser pulses have been observed. In this paper, theoretical models have been established to interpret the formation process of subwavelength periodic ripples etched by nanosecond pulsed laser, and some key questions have been discussed.

Keywords: silica films; laser induced damage; subwavelength ripples; nanosecond pulsed laser.

1 Introduction

Among the physical, chemical, and mechanical nanofabrication techniques, laser-assisted nanofabrication techniques are efficient and environmentally friendly [1-4]. In laser ablation, the laser-induced periodic surface structures occur in various materials under diverse irradiation conditions [5-7]. Before the advent of the femtosecond laser, a long-pulse or continuous laser was used to obtain ripples with large periods. In a normal-incident situation, the periods of these ripples that are called classic ripples are generally close to the laser wavelength [8-10]. On the other hand, ultra-short pulsed laser-induced ripples have considerably less spatial periods when compared with laser wavelength [11-14]. These ripples are mostly perpendicular to the direction of the laser polarization, and their structures are similar to those of the grating structures, that is, a steep edge exists between the slot and the ridge. This kind of subwavelength periodic ripple has opened a new avenue for laser micro–nano production.

[*] Corresponding author. Tel.: +86-18971145215. E-mail address: zhilin.xia1978@gmail.com (Z. Xia)

[**] Corresponding author. E-mail address: chenshi0205@163.com (S. Chen)