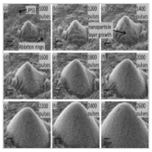

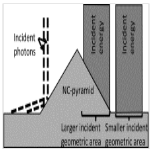

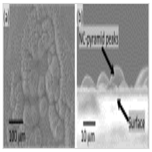

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Applied Surface Science

Available online 9 July 2013

In Press, Corrected Proof — Note to users

Fundamentals of layered nanoparticle covered pyramidal structures formed on nickel during femtosecond laser surface interactions

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http://dx.doi.org/10.1016/j.apsusc.2013.07.002, How to Cite or Link Using DOI
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Highlights

- We report a novel micro/nanostructure: nanoparticle-covered pyramids (NC-Pyramids).
- Stop-motion SEM videos detailing the formation process are presented.
- NC-Pyramids form via ablation with femtosecond laser pulses on metals.
- NC-Pyramids form through preferential ablation and redeposition of nanoparticles.
- NC-Pyramids have a solid core with a nanoparticle shell.

Abstract

The formation of nanoparticle covered pyramidal structures using femtosecond laser pulses with a fluenc near the ablation threshold is reported for the first time. These unique structures form through combination of preferential ablation of flat regions around the pyramids and redeposition of nanoparticle created during the ablation process. The structures are demonstrated on nickel and stainless steel 31(When produced by rastering Gaussian pulses across the sample, layers of nanoparticles join together b sintering to form unique layered shells.

Keywords

Femtosecond phenomena; Laser processing; Microstructuring; Nanostructuring

1. Introduction

Femtosecond laser surface processing (FLSP) is a rapidly developing technology that can be utilized fo creating specialized micro/nanostructures on the surface of various types of materials. The wide range o and precise control over the surface morphologies enable precise tailoring for specific applications. A larg variety of micro/nanostructured morphologies fabricated by FLSP have been reported in the literature including pillars [1], [2], [3], [4] and [5], cones [6], [7], [8], [9], [10] and [11] spikes [3], [12], [13] and [14 and mounds [15]. All of these surface morphologies share similar characteristics, namely microstructure with a height to width aspect ratio of at least 2:1, widths around 2–10 μm, and either nanoripples o nanoparticles covering the surface. In this work, we present for the first time a new surface morpholog fabricated via FLSP that is referred to as nanoparticle covered pyramids (NC-pyramids). NC-pyramic have a pyramidal shape and are covered with a thick layer of nanoparticles (typically >2 μm thick). Th NC-pyramids have an aspect ratio near 1:1 and can grow to be more than 50 μm in height and width. In recent publication covering FLSP, we demonstrated that different values of the laser fluence lead t dissimilar formation processes for mound-shaped structure growth and therefore unique surfac morphologies [15]. NC-pyramids are another unique surface morphology that result from using FLSP a