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PII: S0921-5093(18)30625-7
DOI: <https://doi.org/10.1016/j.msea.2018.04.105>
Reference: MSA36425

To appear in: *Materials Science & Engineering A*

Received date: 7 April 2018
Revised date: 24 April 2018
Accepted date: 25 April 2018

Cite this article as: Lan Chen, Xudong Ren, Wangfan Zhou, Zhaopeng Tong, Samuel Adu-Gyamfi, Yunxia Ye and Yunpeng Ren, Evolution of microstructure and grain refinement mechanism of pure nickel induced by laser shock peening, *Materials Science & Engineering A*, <https://doi.org/10.1016/j.msea.2018.04.105>

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Evolution of microstructure and grain refinement mechanism of pure nickel induced by laser shock peening

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Abstract: This paper investigates microstructure evolution in laser shock peened pure nickel. The microstructure of the deformed layer produced by laser shock peening (LSP) was systematically characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), electron backscatter diffraction (EBSD) and transmission electron microscopy (TEM). Results indicated that the amplitude and depth of micro-hardness in the surface layer increased with the number of laser impacts. A nanocrystalline layer was prepared in pure Ni after LSP and the LSP induced microstructures included dislocations (Ds), ultra-fine laminates (UFLs), ultra-fine grains (UFGs), nano-laminates (NLs), and nano-grains (NGs). Based on the in-depth microstructure observations, a grain refinement mechanism induced by LSP in pure Ni was proposed. The strengthening mechanism of micro-hardness induced by LSP could be attributed to the barriers of dislocation motion, including low-angle grain boundaries, large-angle grain boundaries and dislocation multiplication.

Key words: Laser shock peening; Surface; Plastic deformation; Microstructure; Nanocrystalline

1. Introduction

As an effective method of producing bulk nanocrystalline materials, severe plastic deformation (SPD) has received enormous interests over the past decades [1,2]. SPD imposes intense plastic strain into metallic materials, while it maintains the overall dimensions of the work-piece. SPD processing can lead to a significant grain refinement in pure metals and metallic alloys. Furthermore, the refined grains, which are typically in sub-micrometer or nanometer range,

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