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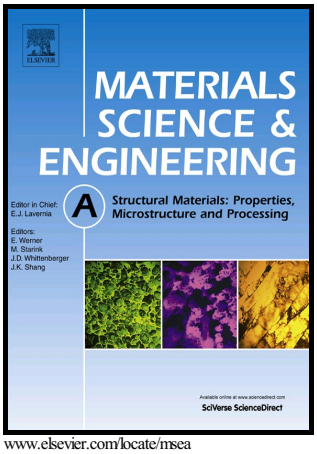

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Evolution of microstructure and grain refinement mechanism of pure nickel induced by laser shock peening

Lan Chen, Xudong Ren*, Wangfan Zhou*, Zhaopeng Tong, Samuel Adu-Gyamfi, Yunxia Ye, Yunpeng Ren
Department of Mechanical Engineering, Jiangsu University, Zhenjiang, 212013, PR China

*Corresponding author: Tel.: +86 511 88780352; fax: +86 511 88780352
renxd@mail.ujs.edu.cn
kinskindom@163.com

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,