

## Accepted Manuscript

Title: Holographic watermarks and steganographic markings for combating the counterfeiting practices of high-value metal products

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PII: S0924-0136(18)30417-5  
DOI: <https://doi.org/10.1016/j.jmatprotec.2018.09.020>  
Reference: PROTEC 15934

To appear in: *Journal of Materials Processing Technology*

Received date: 26-3-2018  
Revised date: 21-8-2018  
Accepted date: 16-9-2018

Please cite this article as: Wlodarczyk KL, Ardron M, Weston NJ, Hand DP, Holographic watermarks and steganographic markings for combating the counterfeiting practices of high-value metal products, *Journal of Materials Processing Tech.* (2018), <https://doi.org/10.1016/j.jmatprotec.2018.09.020>

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# Holographic watermarks and steganographic markings for combating the counterfeiting practices of high-value metal products

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Abstract:

This paper describes recent advances in direct laser writing of tamper-proof holographic structures on metal surfaces for preventing counterfeiting of high-value metal products, e.g. luxury watches, medical tools and implants, collectible coins, etc. Each of these holographic structures consists of an array of optically-smooth craters arranged in such a way to generate diffractive images comprising, e.g. a company logo and/or a string of alphanumeric characters, providing a unique method for the traceability of genuine products. The craters are less than 10  $\mu\text{m}$  across and less than 500 nm deep. They are generated on metals by UV nanosecond laser pulses (355 nm wavelength and 35 ns pulse duration) that lead to localized melting and evaporation of the material. This paper demonstrates various methods for combining the holographic structures with standard marking patterns, such as QR codes and Data Matrices, in order to form aesthetic holographic markings concealing secret messages about the products. By merging a few holographic patterns together it is also possible to generate so called "holographic watermarks". Finally, this article describes a few approaches for making the holographic structures particularly difficult to replicate and

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