



A Brief Introduction to ULOI and RIMAPS Techniques

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I was really surprised when this prestigious Journal of Powder Metallurgy and Mining invited me to be part of the Editorial Board, because I am mostly a physicist characterizing metallic and biological surfaces using different optical and electronic microscopes and during the last years I focus my research interest on biomimeticism (self-cleaning surfaces). As you can see there is nothing about powder metallurgy and mining. However, it is my profound believe that science need to be interdisciplinary and scientists opened-mind. Specialization is fine but sometimes avoids you understanding new facts. I hope that the journal's interest goes in the same way. Let me introduce you one of my research activities: the application of two surface characterization techniques, ULOI and RIMAPS, for the study of topographical patterns.

ULOI

During the past 40 years, the use of laser light has produced remarkable advances in microscopy. In our case, laser light has been used as a source of illumination in the metallographic microscope. The illumination system of the microscope was replaced by a He-Ne laser beam, using an angle of incidence between 5° and 15° with respect to the surface of the sample. We analyzed the variation of the intensity (I), measured in volts with a phototransistor, of the laser light dispersed by the surface of a crystalline grain as a function of the angle of rotation (ϕ) of the sample around a perpendicular axis to its surface (Figure 1). This fact is partially related to the crystalline orientation of the grain as well as with the chemical solution used to reveal the structure of the material. We named this technique of illumination Unidirectional Laser Oblique Illumination (ULOI) [1,2]. Each maximum of the $I(\phi)$ curve corresponds to one of the main directions of the surface topography. The main factor of this illumination is not necessarily the precise observation of the surface roughness, which is partially harmed by the speckle produced by the high coherence of the laser, but the possibility of detecting some surface structure that is below the resolving power of the objective.

RIMAPS

The utility and acceptability of images obtained from different microscopes, with no prior knowledge of the type of microscopy (optical or electronic) used to form the image of three dimensional objects, depend on the direct interpretation that can be made from them by any observer. A simple 'eye-inspection' is not enough to obtain all the characteristic topographic patterns from a surface and advanced imaging techniques are imposed. Information and resolution depend on the class and operational conditions of the chosen microscopy

technique. It is within this framework that a new imaging technique, capable of overcoming these difficulties in topographic pattern determination, is presented here. Rotated Image with Maximum Average Power Spectrum (RIMAPS) is a technique independent of the class of microscopy and of the conditions used for observation, as long as they remain constant and the whole pattern is present on the observed area. The technique basically consists of rotating the image using commercially available algorithms and computing the x-step of the two-dimensional Fourier transform for each y-line of the new image obtained after rotation. As a consequence, averaged power spectra are obtained for each angular position. If the corresponding maximum values (MAPS) are plotted as a function of rotation angle (RI), valuable information is obtained about the surface pattern under study. By means of this technique, orientation and characteristics of surface topography can be determined (Figures 2 and 3) [3, 4]. These techniques have been applied to study the topographic pattern of biological and technological self-cleaning surfaces [5-8].

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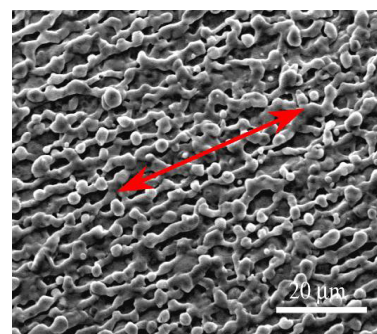


Figure 2: Copper alloy surface treated with laser interference metallurgy. Red arrow shows the apparent main direction of the linear micropattern.

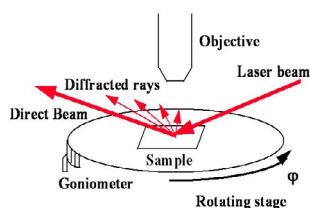


Figure 1: ULOI experimental device..

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Received September 10, 2013; Accepted September 11, 2013; Published September 12, 2013

Citation: Favret E, (2013) A Brief Introduction to ULOI and RIMAPS Techniques. *J Powder Metall Min* 2: e120. doi:[10.4172/2168-9806.1000e120](http://dx.doi.org/10.4172/2168-9806.1000e120)

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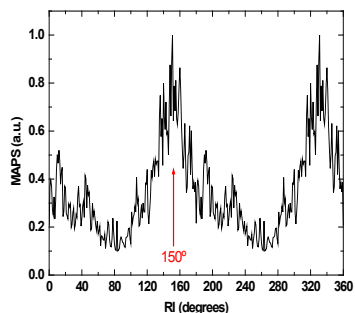


Figure 3: RIMAPS spectrum of Figure 2. This technique detects the main direction of the linear pattern (150°) which coincides with the red arrow of Figure 2.

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Citation: Biswas M (2013) Solid Oxide Fuel Cell. J Powder Metall Min 2: e120. doi:10.4172/2168-9806.1000e120

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