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ADVANCES IN NON DESTRUCTIVE TESTING AND EVALUATION (NDT&E): DEVELOPMENTS AND APPLICATIONS

Telmo G. Santos[1], Patrick L. Inácio[1], Miguel Machado[1], Pamies Teixeira[1], Carla M. Machado[1(*)], Rosa Miranda[1], Carla C.C. R de Carvalho[2]

[1]UNIDEMI, Faculty of Science and Technology, Universidade Nova de Lisboa, Almada, Portugal
[2]IBB-Institute for Bioengineering and Biosciences, IST/ University of Lisbon, Lisbon, Portugal
[(*)]*Email:* cmm@fct.unl.pt

ABSTRACT

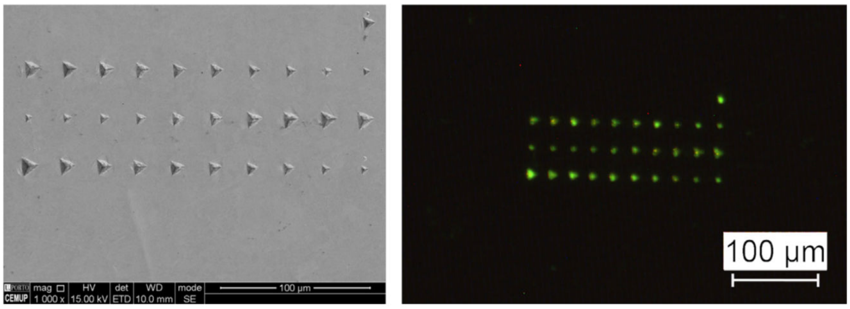
This paper reports current capabilities in Non Destructive Testing and Evaluation (NDT&E) of the NOVA NDT Lab at the Mechanical and Industrial Department of FCT-NOVA, some of them in collaboration with iBB-Institute for Bioengineering and Biosciences at IST. An innovative NDT technique was developed to detect micro and nano surface defects using bacterial cells. Some results of material characterization based on mapping the electrical conductivity with eddy-current and four-point probe are presented, as well as the detection of surface defects in stainless steel alloy pipes using customized NDT eddy-current probes.

Keywords: NDT, eddy-current, material characterization, bacterial cells.

INTRODUCTION

Non Destructive Testing (NDT) is the branch of engineering concerned with all methods of detecting and evaluating flaws in materials or differences in their morphology, without destroying their serviceability. The research approach of NOVA NDT Lab is to develop customized NDT systems for specific industrial applications from the problem to the solution.

A new NDT technique for surface micro defects has been developed exploring different attributes of bacterial cells, such as: small dimensions, high penetration capacity, motility, adherence, fluorescence and response to electric and magnetic fields (Telmo, 2016). The technique was applied in several materials, including in nanoindentions in AISI 316L produced by a standard Berkovich indenter, using the bacteria *Rhodococcus erythropolis* (Figure 1).



(a) (b)

Fig. 1 - Matrix of nanoindentations in AISI 316L observed under SEM (a) and fluorescence microscopy (b). Green dyed *R. erythropolis* cells show indentations (Telmo, 2016).

The electrical conductivity surface mapping has also been explored for characterization of processed materials. Different NDT techniques have been optimized for this purpose, such as four-point or eddy-current probes. The electrical conductivity profile can be correlated with hardness, since the processing affects the microstructure and grain size (Telmo, 2011). A sample of P11 steel (ASME designation) welded by shielded metal arc welding was characterized by the four-point and eddy-current probes and the results were compared to the Vickers hardness test (Figure 2).

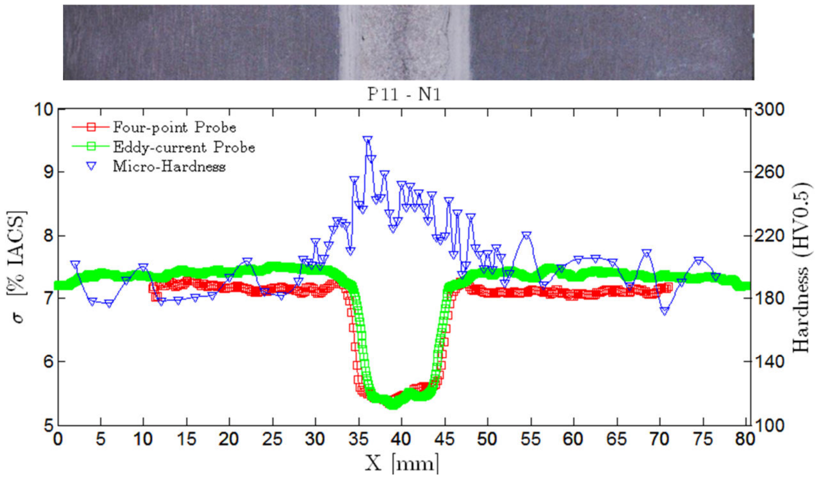


Fig. 2 - Material characterization of P11 Steel (ASME designation) by four-point probe, eddy-current probe and Vickers micro-hardness technique.

Novel eddy current probes were also developed to detect sub-millimetre defects with any orientation on the inner surface of austenitic steel jackets used in ITER. These probes include arrays of planar trapezoidal coils in a flexible substrate with a winded drive coil (Rosado, 2015).

RESULTS AND CONCLUSIONS

The NDT using bacteria allowed the detection of all nanoindentations made, indicating the reliability and usefulness for nano surface defects detection (Figure 1). The mapping of the electrical conductivity profile demonstrated that it can be correlated with hardness and changes in microstructure (Figure 2). Experimental results revealed an improved reliability and sensitivity to circumferential defects of 0.5mm depth when compared to conventional toroidal bobbin probes.

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