Measuring Corrosion with Laser-Ultrasound: Time-Frequency Analysis of Rayleigh Wave Propagation

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Background: Laser-Ultrasound is a new non-contact technique used to detect the defects in the hot surfaces like hot billets etc. Determination of corrosion in the plates, using this non-contact technique seemed a promising research effort.

Objectives: In this work, an inspection system has been presented that uses Laser-Ultrasound (LU) technique for Nondestructive testing (NDT) of metallic structures with specific interest in Oil & Gas sector.

Methods: The developed system is the first one of its kind in the Middle-Eastern region. The nature of signals is quite unique as well and traditional signal processing runs into a lot of algorithmic complications with them. A new approach has been developed for this setup in order to efficiently enhance signal to noise ratio for the underlying signals so that any subsequent classification/intelligent-detection system can be based on the outcomes of this algorithm. Multiform Tiltable Exponential Distribution (MTED) kernel, which is a generalization of 2nd order Cohen’s class functions in Time-Frequency Representation (TFR) space, has been used in this work to isolate the essential frequency components with temporal and frequency based masking filters.

Results: While detecting defect points is quite similar to the conventional ultrasonic testing, the detection of corrosion is quite different. The reason being is the surface properties, and hence the surface vibrations, are quite different for a corroded surface as compared to a polished surface. In this respect, we have observed the propagation of the surface Rayleigh waves manifests a pattern that can be mapped to the corrosion concentration on the surface.

Conclusion: Interesting observation has been made with coated corroded surfaces where the behavior has been found to be quite similar. Thus, the underlying technique can be applied without any need to remove the coatings from the sample under study.

Special Characteristics of Ingot Castings and Extrusion Ingots Produced at the Qatalum Aluminum Production Site

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The quality of raw materials used for primary aluminium production vary depending on the location they originate from. Consequently, the level of trace elements found in the raw materials varies from location to location and so does the chemistry of the final product. While the effect of trace elements is difficult to quantify, they may have a significant impact on both process ability and the properties of the final product. The raw materials used in the aluminium production at the Qatalum facility in Qatar might have quantities of some chemical elements above that seen at other production facilities around the world. Therefore, the present project aims at (i) discovering the effects of aluminium alloy constituent calcium (Ca) and phosphorus (P) on segregation in ingot castings and (ii) revealing the influence of trace elements such as vanadium (V) and nickel (Ni) on extrusion performance and properties. Typical ingot castings from Qatalum have been characterized and compared to castings from the Hydro Sunndal production facility in Norway. Moreover, extrusions from billets cast at Qatalum have been subjected to a series of analyses with respect to the influence of trace elements such as vanadium (V) and nickel (Ni) on extrusion performance and properties. Typical ingot castings from Qatalum have been characterized and compared to castings from the Hydro Sunndal production facility in Norway. Moreover, extrusions from billets cast at Qatalum have been subjected to a series of analyses with respect to the influence of the trace elements mentioned above. Again, for comparison extrusions of billets cast at Hydro Sunndal will be used for reference. In achieving these goals a series of advanced techniques in metallography and elemental analysis as well as mechanical tests were employed to reveal the characteristics of the Qatalum special alloy compositions and benchmark castings and extrusion profiles microstructures and properties against fully controlled reference materials.