

Solution to Reconstruct the Height Correlation Function of a Randomly Rough Surface Using the Diffuse Scattered Elastic Waves

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The scattering of elastic waves provides a way for subsurface sensing of surface conditions, which may be applied in NDE to characterize crack-like defects within a component or corrosion surfaces on a remote surface such as the inside of a pipe. In [1], a methodology has previously been suggested to estimate the surface RMS value using a single transducer performing the pulse echo inspection. The conventional formulae representing the exponential decay of the expected coherent intensity in the specular direction as a function of the RMS value was applied in that work. Apart from the RMS roughness, the surface correlation function is also very important as it describes the lateral variation of surface height. However, so far there has been no solution found to reconstruct the height correlation function, since it is strongly related with the diffuse field whose analytical form was not accessible until recently. In [2] we have developed an analytical expression to represent the elastic wave diffuse field, on the basis of which we proceed in this study to develop a solution to reconstruct the complete correlation function from the diffuse field.

The methodology relies on the angular measurement of the expected diffuse intensity within a narrow frequency band using a phased array. In practice, multiple scans of different parts of the surface need to be performed using a phased array, so that the expected intensity at different angles can be obtained by averaging the intensities from all scans. The diffuse intensity is then extracted by subtracting the coherent intensity from the mean total intensity. By applying the developed inverse algorithm, the correlation function can be recovered from the diffuse intensity.

In this study, numerical simulations via the Monte Carlo approach using multiple surface realizations are run to obtain the expected angular distribution of the diffuse intensity, which is then used in the inverse algorithm to reconstruct the correlation function. Results show that the developed method successfully reconstructs the height correlation function for a range of RMS values from low to high roughness.

References:

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2. F. Shi, M. Lowe, X. Xi and R. Craster, "Diffuse scattered field of elastic waves from randomly rough surfaces using analytical Kirchhoff theory," *J. Mech. Phys. Solids*, in press, 2016.