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Application of textural analysis for research the relationship between the microrelief of surfaces and laser speckles

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This work investigates the use of texture analysis to establish a quantitative relationship between laser spot properties and the microrelief parameters of metal surfaces.Surface microreliefs, consisting of microscopic irregularities, play a crucial role in determining material properties. Analysis of these irregularities is crucial in materials science for predicting behavior, developing materials, and quality control. Traditional methods exist, but laser speckle interferometry offers a non-invasive, precise alternative. When a laser beam interacts with a rough surface, it is scattered, forming a spot pattern that encodes statistical information about the surface. Our study investigates whether this information can provide insights into the properties of microreliefs.

We analyzed seven metal samples and captured microscopic images using dark-field microscopy and speckle images using a special optical setup. Texture parameters such as fractal dimension, anisotropy, contrast, correlation, entropy and second angular momentum were calculated. The results showed a strong Pearson correlation between three key parameters: fractal dimension, anisotropy and entropy, which is consistent on both micrographs and speckle images.

This correlation implies that speckle texture analysis can effectively characterize the underlying microrelief of metal surfaces. The fractal dimension of speckles reflects the complexity of the surface, anisotropy indicates directional variations in roughness, and entropy captures the randomness of the surface texture. Our results suggest that speckle analysis can serve as a powerful tool to study and predict material properties, enabling non-invasive quality control and material design.

Type of presence

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