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Application of THz-time domain spectroscopy to the evaluation of thin films

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Abstract– We present applications of terahertz time-domain spectroscopy for the nondestructive evaluation of thin films. We combine physical properties of the interaction between THz waves and materials with signal and imaging processing. We illustrate with the evaluation of mill scale on steel, of conformal coatings on integrated circuits, and of multi-layer paint on a variety of substrates.

Summary

Terahertz (THz) radiation penetrates a number of non-conducting materials and as a result can be useful for surface and sub-surface nondestructive characterization, evaluation, and testing of materials and devices. Depending on the material and available power, THz waves can penetrate from mms to tens of cms, and axial resolution can go from hundreds of microns to a few microns. In this review, we will present recent results obtained by our team on the analysis of a variety of coatings with THz time-domain spectroscopy. Signal processing and machine learning techniques that we have applied to increase axial and lateral resolution and to improve classification tasks will also be presented [1,2,3].

In particular, on metal substrates, we have been able to characterize thin films such as the mill scale [4] appearing during the hot-rolling of steel, the thickness of individual paint layers in multi-layer paint [5], as well as corrosion under a paint layer [6].

In the field of cultural heritage conservation, THz imaging has proven successful in determining the stratigraphy of a XVIIth century oil painting on canvas [7] and in reading inscriptions, under a fin oxide layer, on a XVIth century lead cross [8].

Finally, we will present recent results on the investigation of conformal coatings (thickness and defects) on integrated circuits.

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