Editorial
Special Issue: Nondestructive Evaluation of Material Surfaces: Theory, Techniques, and Applications

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Due to the fast-growing industrial world, the demand for characterization tools and techniques has increased equally. To improve the performance of materials without compromising their inherent properties, various surface characterization techniques are developed. The advances in material surface developments have led to a wide range of material surfaces, coatings, and thin films. Corrosion resistance, thermal barrier, electrical insulation, and fretting fatigue resistance are some of the properties that can be achieved by proper surface treatments or the utilization of coatings. Many surfaces modification, surface alteration, and enhancement techniques are available in the literature. Many of them are commercially used in marine, aeronautical, and aerospace industries. For ensuring the efficiency of these improved material surfaces, the development of appropriate characterization techniques is of paramount importance.

Due to the dimensional limitations of the material surfaces, non-uniform stress distributions under static and dynamic loads, and unexpected system responses, the characterization of material surfaces is challenging. Nonetheless, the rapid, accurate, and affordable characterization of surfaces and sub-surfaces of a material can be achieved by using nondestructive evaluation (NDE) techniques. Researchers around the world have developed various NDE techniques for measuring the surface characteristics and for diagnosing the surface defects. Giurlani et al. reviewed the nondestructive methods available for measuring the thickness of metal coatings [1]. Ostiguy et al. used guided waves [2], while Zhang et al. [3] and Ma et al. [4] used ultrasonic waves for measuring the coating thickness that serves as thermal barrier. Eddy current techniques and energy dispersive X-ray fluorescence testing were used by several researchers [5]. Thermal techniques such as thermal wave imaging, active and transient thermography, and infrared thermography are used by several researchers to characterize the surface coatings and to diagnose defects in surfaces and sub-surfaces [5–8].

The research on material surfaces is not limited to measure the thickness or the other surface properties. It also involves studying the performance of the coatings or modified surfaces under mechanical, thermal, and electrical loading in different ambient conditions. Composite and ceramic coatings are susceptible to delamination, pit formation, barely visible impact damages, and cracks due to the non-uniform stress distribution. In addition, these coatings may also have some defects due to the nonuniformity in coating, porosities, and impurities. These defects adversely affect the performance of these coatings. Various NDE techniques are employed by different researchers to identify these defects and analyse the performance of the coatings. Ultrasonic testing, infrared thermography, eddy current testing, X-ray radiography, magnetic particle testing, laser shearography, optical coherence tomography, microwave-based techniques, terahertz time-domain spectrography, X-ray diffraction, and acoustic emission are some of the nondestructive techniques used by researchers for characterizing the material surfaces [5,8–12]. Each of these techniques has inherent advantages and limitations with respect to one another. The number of literature available on each of these techniques guarantees that there is no selective technique for
characterizing material surfaces. However, based on their application, they have significant differences. The accuracy, resolution, and applicability of these techniques vary from one another significantly.

Nondestructive techniques have been available for decades, but how has it become more accurate, affordable, and efficient in recent years? This tremendous development is attributed to the development of data processing algorithms, signal processing tools, and advanced computational tools and hardware. Not to say the least, machine learning algorithms have played a significant role in the applicability of NDE techniques in material surface characterization. Several researchers have used machine learning algorithms to successfully characterize the material surfaces and the characteristics of coatings and thin films [13–15]. Reviews by Mao et al. [16] and Fu et al. [17] highlight the applicability and advantages of using these techniques to support nondestructive techniques.

Although the advantages and the limitations of different NDE techniques for material surface characterization are argued over the years, the database is not complete. This Special Issue is aimed at enriching the library of NDE techniques available for characterizing material surfaces. This is not limited to the collection of available techniques but is also aimed at the recent advancements in these techniques.

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