THE IMPACT OF MODELING, SIMULATION, AND CHARACTERIZATION OF THE MECHANICAL PROPERTIES OF NANO-MATERIALS IN THE NANOTECHNOLOGY INDUSTRY.

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ABSTRACT

As part of the advances in nanoscience, nanoindentation has emerged in recent years as the most important probe for investigation of mechanical properties over dimensions ranging from a few nanometers to a few microns. In this investigation, NanoTest 550 indenter presents a unique lateral testing technique which in contrast to other indentation methods like scanning tunneling microscopy, and atomic force microscopy provides perfectly normal force and load applied evenly on specimen surface. It also minimizes the effect of gravity common in most nanoindentation modules. This technique provides a method by which load displacement curve resulting from the nanoindentation test is used to estimate the mechanical properties (elastic) of materials. It is also used to study the mechanical properties of other thin films and small volume materials as well.

The NanoTest 550 has been used to characterize the mechanical properties of four materials, namely fused quartz, aluminum, copper, and phenolic plastic. The Elastic Modulus determined from the experiments was quite accurate. The results gave a standard deviation of less than 0.5 and a margin of error of less than 3% when compared to the materials' specifications. The use of nanoindentation experimental technique in the manufacturing industries will be very strategic due to the fact that several other mechanical properties, apart from Elastic Modulus and hardness, can be determined from the data generated. The work is aimed at establishing nanoindentation experimental techniques as a rapid and non destructive means of determining the mechanical properties of the materials in the manufacturing process and material development and to correlate nanoindentation techniques with constitutive approach of mechanical characterization. The result is consistent with earlier results from other established nanoindentation procedures.

Nanotechnology is the creation of functional materials, devices, and systems through the control of matter on the namometer length scale (1 to 100 nanometers), and exploitation of novel phenomena and properties (physical, chemical, biological) at that length scale. The research at Tennessee State University is aimed at computer modeling and simulation of nanomaterials. The materials modeled and simulated are produced. After production, the materials are characterized using the Nanotest 550. The development of the process of modeling, simulation and property characterization stands to impact the nanotechnology industry greatly.