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IDENTIFICATION OF ELASTOPLASTIC PROPERTIES OF COATED NANOSTRUCTURED OPTICAL WINDOWS FROM BERKOVICH NANOINDENTATION EXPERIMENTS USING FEMU METHOD

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Optical transmitting materials such as Ge, Si or glass, are widely used in military optronic systems. They are found on vehicles, ships and soldiers for use in visible or infrared imaging systems. These optical windows must operate in harsh environments and transmission losses due to light reflections or surface obstructions cannot be tolerated. Thus, antireflective and superhydrophobic properties are needed for these applications. One way to achieve a combined anti-reflective and superhydrophobic optical window is to pattern nanostructures directly onto the material's surface. However, designing nanostructures onto the surface such as cones or pillars lead to sub-optimal mechanical properties compared to pristine surfaces. One possibility to strengthen these nanostructured optical windows is to deposit a thin hard coating, such as alumina, followed by annealing at high temperature to induce densification and crystallization.

In this context, the identification of the elastoplastic properties; elastic modulus E, yield strength σ_Y and hardening modulus H; of this film is challenging and furthermore essential for developing the optimal coating and nanostructures geometry. Based on a 2D axisymmetric finite element modelled nanoindentation test, elastoplastic properties are estimated using Finite Element Model Updating Method (FEMU), by matching load-displacement curves with nanoindentation measurements.

Instability of the inverse problem solution has been shown, from the identification of these 3 parameters E, σ_Y and H, by combining nanoindentation experiments with two different coated substrates. By defining an identifiability indicator [1], we will be able to evaluate the good or bad conditionning of the inverse problem and adapt the experiments to consider for a reliable parametric identification. Moreover, it has been shown that introducing the residual area [2] of a profile indenter in the inverse analysis could improve the parameter identifiability, by describing more precisely the hardening phenomena.

Thus, the aim of this talk is to discuss about this challenge of extracting mechanical properties from instrumented indentation and Atomic Force Microscopy of a coated nanostructured surface.

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