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# Understanding Mechanisms of Adhesion of SiO<sub>2</sub> Thin Film Deposited on a Polymeric Substrate

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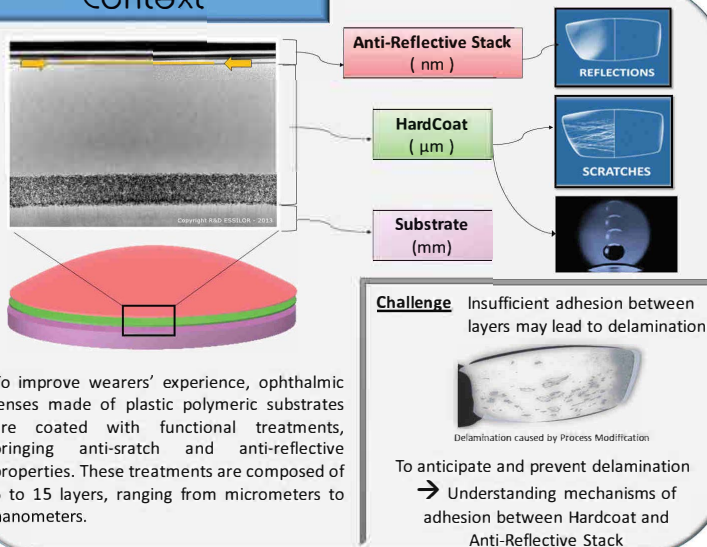


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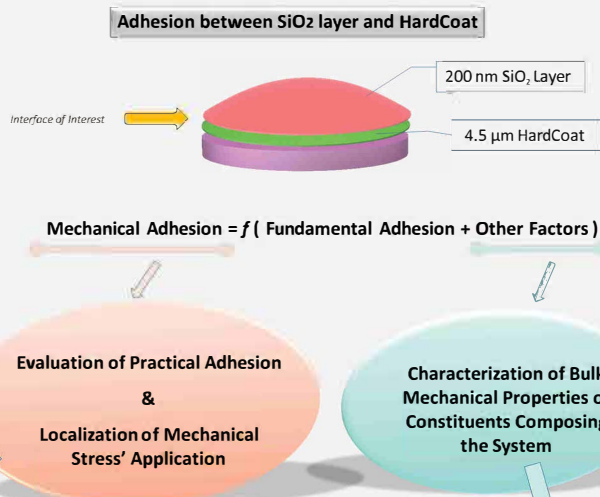
**Abstract** : A better understanding of mechanisms of adhesion between a 200 nm thick silicon dioxide layer and a 4.5 μm thick polymeric hardcoat is indispensable for an efficient adhesion at the interface. To reach this purpose, focus is placed on two axes: finding an applicable and effective method to quantify adhesion and in parallel, characterizing mechanical properties of materials composing the system. The second axis is needed to obtain data to feed modeling codes, enabling a better analysis of the adhesion experiment. Modulus of modified SiO<sub>2</sub> was found to be roughly 20% higher than reference SiO<sub>2</sub>, by nanoindentation. AFM experiments showed no difference between modified and reference SiO<sub>2</sub>. Currently, an investigation to detect cracks at the interface of interest for micro-tensile test is ongoing. Adhesion tests, such as micro-compression will be performed as well.

## Context



To improve wearers' experience, ophthalmic lenses made of plastic polymeric substrates are coated with functional treatments, bringing anti-scratch and anti-reflective properties. These treatments are composed of 5 to 15 layers, ranging from micrometers to nanometers.

## Methodology



## First Results

### Micro-tensile test

**Force applied versus Sample Extension**

**Agrawal and Raj model**

$$\tau = \frac{\pi \delta \sigma}{\lambda}$$

$\tau$ : maximum interfacial shear strength in MPa  
 $\delta$ : film thickness in μm  
 $\sigma$ : stress at first cracking occurrence in MPa  
 $\lambda$ : mean inter-crack spacing at steady state in μm

**SEM micrographs of fractured tensile specimens**

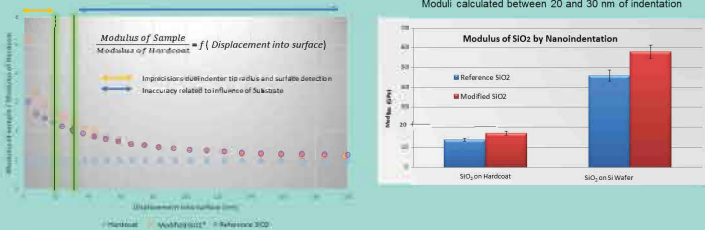
Identification of layers after tensile test by EDS

**HardCoat / Substrate interface: [ 9 ; 14 ] MPa**

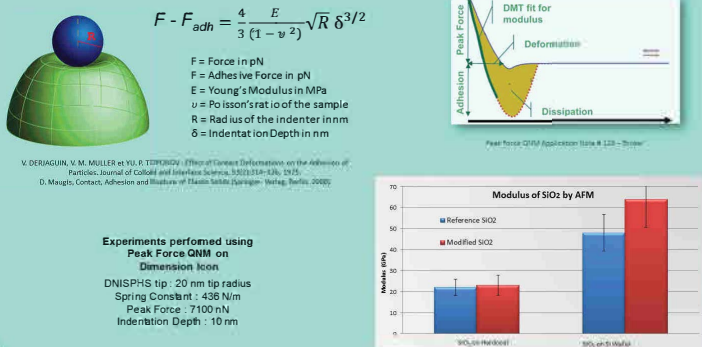
Variability due to :-

- Determination of first Cracking occurrence
- Determination of Steady state

## Nano-indentation



## AFM



Acknowledgement : Mickael Febvre from Bruker for performing the AFM experiments

## Conclusion and prospects

First micro-tensile experiments suggest that most noticeable cracks are located at the hardcoat/substrate interface. This was determined by EDS on fractured areas, after tensile experiment. Modulus of modified SiO<sub>2</sub> was found to be roughly 20% higher than reference SiO<sub>2</sub> by nanoindentation. Considering the high standard deviation of moduli measured by AFM, no significant difference between moduli of modified and reference SiO<sub>2</sub> was observed by AFM. However, an important difference between moduli of SiO<sub>2</sub> on lens and on Si wafer was observed. This exposes unexpected influence of substrate on mechanical measurements using AFM, which has been hypothetically attributed to impact of Peak Force high frequency oscillations on viscoelastic substrates. Currently, an investigation to detect cracks at the interface of interest after micro-tensile test is ongoing. Other adhesion tests, such as micro-compression will be performed as well.