PhD THESIS DEFENSE: Transparent surfaces based on ultrathin materials with tailored optical and biological functionalities

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15:00

ICFO Auditorium and Online (Teams)

The properties of ultrathin materials present exciting opportunities to develop multifunctional surfaces. In addition, the use of plastic and thin glass as transparent substrates has the potential to extend the use of ultrathin materials beyond conventional substrates and provide vital advancements to existing and emerging technologies across a wide range of sectors. One of the main challenges facing next-generation transparent substrates is the substantially reduced temperature processing window which is not compatible with materials requiring high fabrication temperatures. This thesis describes the development of

fabrication techniques to obtain ultrathin materials on low thermal budget transparent substrates to create surfaces with advanced optical and biological functionalities. More specifically, this thesis describes:

A novel, low temperature transfer technique onto flexible substrates for ultrathin materials such as graphene, molybdenum disulfide and nanostructured metals that were previously grown at a much higher temperature. The universality of the method extends the use of these ultrathin materials to a wide range of technologically relevant substrates such as cover glass for display modules and polymeric substrates for next generation foldable and bendable electronics.

A novel approach to increase electrical conductivity of transparent surfaces based on graphene, without the need of post-treatment, electrical gating or high temperatures. Notably, the method achieves a conductivity of comparable magnitude or greater than what is reported in previous studies. Furthermore, the increase in electrical conductivity is realised simply by utilizing an ion-exchanged substrate, a technologically relevant transparent glass substrate that is widely used in touch screen displays (e.g. smart phones).
A low temperature metal dewetting technique to obtain transparent antimicrobial nanostructured coatings on a cover glass substrate for display modules. The durability of the coatings was evaluated under conditions designed to simulate

real-world use cases such as capacitive touch displays. The results show that the coatings were capable of substantially retaining optical properties of the underlying substrate, such as haze, neutral colour, and visible light transmission, as well as retaining antimicrobial properties after repeated contact with external objects such as, for example, when wiping with a towel or cloth, or touching with human fingers.
The results of this thesis demonstrate the implementation of ultrathin and nanostructured materials, such as graphene and nanostructured metals onto a wide range of technologically relevant transparent substrates, by methods that are industrially scalable and compatible with low temperature processing. At the same time, surfaces are engineered with advanced optical and biological functionalities that are relevant for applications such as transparent electrodes and antimicrobial coatings .
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Thesis Director: Prof Dr. Valerio Pruneri

Hosted by: Prof. Dr. Valerio Pruneri and Academic Affairs