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SEMINAR

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Host: Prof. Luis M. Liz-Marzán

Biomimetic Nanocomposites

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Materials that are multifunctional, structurally versatile, and resource conscious, represent the critical bottlenecks of nearly all modern technologies -- the qualities typical of components of many living tissues. Although the notion of Nature-inspired materials is known for hundreds of years, the true challenges for transition from superficial replication some geometrical parameters to purpose-driven biomimetic materials design become fully appreciated. Perhaps, the *first* and central one among these challenges is the multiplicity of scales spanning ten orders of dimensional organization from *Ångströms* to meters. The *second* one is deciphering the universal design principle of biomimetic materials that would be applicable across scales and functions.

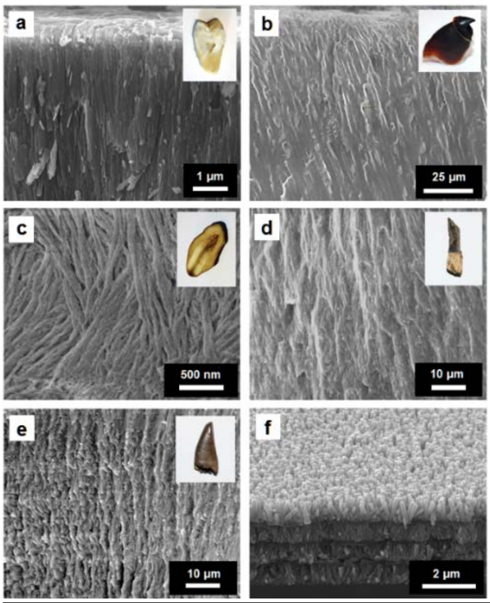

Figure 1. Tooth enamels (**a-e**) and their nanocomposite replica (**f**). SEM images of (a) enamel of a Homo sapiens tooth, (b) *Octopus Vulgaris*, (c) an ancient walrus from the *Odobenidae* family, (d) *Tyrannosaurus Rex*, (e) *Albertosaurus spp*, and (f) biomimetic enamel-inspired composites based on ZnO NWs.

In this talk, I will make a step toward addressing these challenges using layer-by-layer assembly (LBL/LbL) toolbox that affords nanocomposites engineered with structural control over seven orders of dimensional organization. Multiple mechanical, electrical, optical, biological, etc parameters can be independently optimized due to rare versatility of LBL assembly. The control of the interfacial adhesion and homogeneity of LBL composites enables evaluation of different hypothesis of what biomimetic design principles might be, which is difficult for other composites.

Replication of load-bearing and functional nanocomposites taking advantage of LBL will be described for theree examples on iconic nanomaterials: nacre; enamel and cartilage. Nacre-like composites allow for multidimensional design of materials properties: toughness, stiffness, strength, transparency, conductivity; ion transport, polarization rotation, and biological response. Replicating tooth enamel, we recently learn that the mechanics and other properties of this material can be replicated combining out-of-plane nanoparticle assembly into columns and LBL assembly of polymers in between them (**Figure 1**). These composites reveal remarkably high vibrational damping unusual for stiff materials that imparts them resilience to aging. Replication of cartilage gives example how to nature reconciles load-bearing and transport properties. Energy, biomedical, and optoelectronic applications are in the center of our translational work with LBL nanocomposites and will be discussed as well.

References:

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