Bottom-up Nanostructuration in Hybrid Materials for Emerging Applications

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Today everything from materials, technologies, devices and machines to thinking or AI is or is becoming hybrid. The key driving force behind these transformations, fueled and supported by new generation of sciences and technologies, is society's increasing demand for high functionality and performance with reduced energy consumption and costs, ensuring high accessibility.

"Hybrid" means creating synergy by combining elements previously considered differernt to generate something entirely new. In materials science, nanotechnology has paved this path. Notably, the highly versatile solution-based bottom-up approaches have enabled the creation of true molecular hybrids. This starts from molecules and achieves the controlled assembly of nanometric (macro)molecular entities through chemical and intermolecular bonds. Entities smaller than 10 nm, known as building blocks, exhibit quantum effects. Thus, quantum synergy has emerged through the interactions at the nanoscale of the electronic structures and properties of different classes of chemical compounds (inorganic vs. organic). This has given rise to a "hybrid world" with theoretically unlimited development possibilities.

The presentation consists of two parts. The first part provides a brief overview of the fundamental aspects of nanochemistry and nanostructured hybrid materials, highlighting their potential for new applications. The second part presents some research conducted by the Laboratory of NanoChemistry-Center of Nanostructures and Functional Materials from UDJG in collaboration with partners from CENIMAT-i3N Nova University of Lisbon, Fraunhofer Institute for Integrated Systems and Device Technology IISB of Erlangen, "I. G. Murgulescu" Institute and "P. Poni" Institute of the Romanian Academy. The focus is on the synthesis of 0D, 1D, and 2D nanostructured hybrids for applications in transparent and flexible electronics, photocatalysis, antimicrobial and biomimetic coatings.

Keywords: *Nanochemistry, building blocks, molecular hybrids, 0D/1D/2D nanostructured hybrids, transparent&flexible electronics, photocatalysis, antimicrobials, biomimetic coatings.*