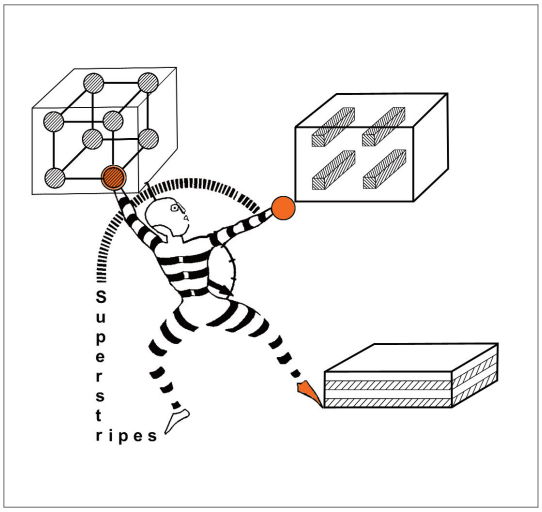
Atomically Controlled Surfaces, Interfaces and Nanostructures



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These authors presented the scientific reports collected in this book at the ACSIN 2016 conference held in in Frascati, Rome, Italy, Oct 9-15, 2016.

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Mo1T session

A. Acun et al. “Atomically Controlled Surfaces Interfaces and Nanostructures”
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Near-Field identification of gold nanoshells inside cells

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Key words: Scanning Near-Optical Microscope, Near-Infrared biological transparency window, gold nanoshells.

Because of their strongly resonant light-absorbing and light-scattering properties that depend on shape, noble metal nanoparticles (NPs) provide a new and powerful tool for innovative light-based approaches both in nanophotonics and nanomedicine. In particular in medicine, gold NPs nanoshells (AuNPs) met large interest and have found application for cancer treatments. The use of plasmonic nanoparticles as highly enhanced photoabsorbing agents has thus introduced a much more selective and efficient cancer therapy strategy. This is because at wavelengths just beyond the visible spectrum in the near-infrared, blood and tissue are maximally transmissive. As a consequence, by manipulating AuNPs shape and dimension, it is possible tune the optical resonance of such NPs to this region of the spectrum so that they become useful contrast agents in the diagnostics imaging of tumors. In addition, when illuminated by an external near-infrared (NIR) source, NPs can serve as nanoscale heat sources, phototermally inducing cell death and tumor remission, the so-called plasmonic photothermal therapy (PPTT).
In addition, in biological applications, the AuNPs must be coniugated with biomolecules in order to recognize cancer cells. A satisfactory study of the interaction between single cell-single AuNP should define and delineate the basic key-mechanisms induced by the conjugated biomolecules for selective cellular uptake for cancer cells. In fact, the best conjugating biomolecules with AuNP able to recognize and bind target cells. In turn, their response to illuminating NIR light when internalized in the cancer cells requires useful strategies to be studied.
The possibility to study the interaction between single cells-sigle AuNPs is based on the ability to identify the AuNs inside the cells. An innovative contribution for such identification has been recently made by D’Acunto and co-workers demonstrating the possibility to identify single AuNPs with dimensions 100-150nm, inside a single h9c2 mouse cell, figure 1, using an illumination wavelength of 780nm [1-3]. This demonstration opens the possibility to study the single NP uptake and the inside cell thermal induced effect before the cells being eventually destroyed as in standard PPTT.
Such progress and the correspondent ability to study the interaction between single AuNP-single cell has been made possible by the usage of Scanning Probe Microscopy (SPM) techniques. SPM denotes a versatile family of scanning microscopies with spatial resolution of nanometers. In our experimental setup, we used a home-made aperture Scanning Near-Optical Microscope (SNOM) operating in air. In turn, a near-

field Green based Mie theory for the quantification of near-field optical properties of the AuNPs has been developed to calculate the *z*-localization of the AuNP inside the cells [4].

Figure 1: (Left), 20μm×20μm topography of h9c2 mouse cell recorded with a home-made aperture SNOM; (middle) an overlapping of the topography image with the correspondent optical map, the arrows denote the (120nm diameter) nanoparticles identified within the cell; (right), strong-absorption points marked by arrows in the overlapping image and denoting the dimensions of the nanoshells.

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