Nanoscopy for Nanomedicine: looking at nanomaterials one molecule at a time

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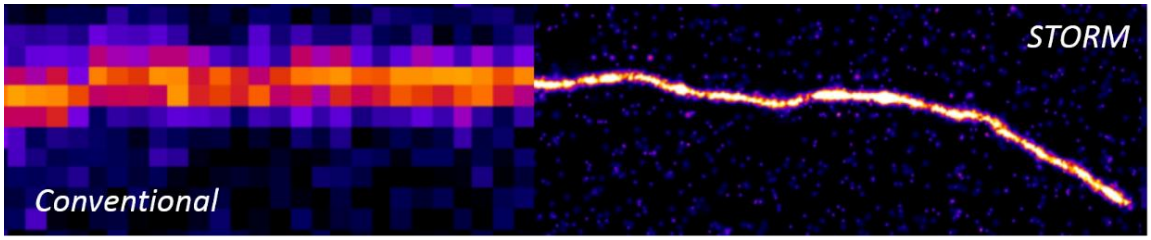
The development of nanocarriers for intracellular delivery of therapeutic moieties is a great challenge for synthetic chemistry and nanotechnology. A crucial factor limiting the design of effective materials is the lack of understanding about material-cell interactions that hampers the rational design of nanosized carriers. Therefore obtaining detailed information about the behavior of nanomaterials in the biological environment is a key issue in nanobiotechnology.

Here we discuss the use of super resolution microscopy to image materials in vitro and in mammalian cells. This novel technique, allowing to obtain a resolution down to 20nm, had a dramatic impact in the field of cell biology, however its use in the field of chemistry and nanotechnology is poorly explored. Super resolution microscopy offers nanometric resolution and multicolor ability, therefore it is an ideal tool to study nano-sized supramolecular assemblies of multiple components in vitro and in cells. We employed Stochastic Optical Reconstruction Microscopy (STORM) to image biomaterials in vitro, with special emphasis on supramolecular polymers and nanoparticles, unveiling novel information on materials structure and dynamics.



Moreover we propose a methodology to image nano-sized materials in cells, tracking them during their membrane targeting, cell uptake and intracellular targeting. We show how 2-color STORM can be used to perform nanometric-accurate colocalization unveiling at the molecular level materials-cell interactions. These methodologies are used to answer open questions in the nanobiotechnology field related to the interactions of nanosystems with the cellular environment. This allows looking at nanomaterials in action with new eyes and use the information obtained for the “STORM-guided” design of novel nanomaterials for drug delivery and other targeted therapies.

Multicomponent Supramolecular Polymers as a Modular Platform for Intracellular Delivery
ACS Nano, 2016, 10 (2), 1845–1852

Super Resolution Imaging of Nanoparticles Cellular Uptake and Trafficking
ACS Appl. Mater. Interfaces, 2016, 8 (10), pp 6391–6399

Probing exchange pathways in one-dimensional aggregates using super resolution microscopy
Science, 2014, 344(6183): 491-5