COST Action MP 1302 Nanospectroscopy
Meeting of Working Group 3 - Improving Spectroscopic Techniques
at the annual COST Action MP1302 conference Optical Nanospectroscopy I
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28.03.2014

As one of the objectives and deliverables of the COST Action, a list of current issues for improving spectroscopic techniques was drafted based on a round-table discussion including members from academia and industry. The following main themes emerged from this exchange of ideas:

Perspectives for Improving Spectroscopic Techniques

- **Equipment, logistics and manpower:** Many issues mentioned by the WG members fall into the category of practical experimental problems related to limited infrastructure and/or insufficient manpower at the individual participating institutions. An important first step will therefore be to improve the information on the COST website so that all partners have a complete overview of all the equipment, facilities and expertise that is available within the COST Action, allowing for more efficient networking and planning of new collaborations and short-term scientific missions. A dedicated database and an online forum were also mentioned as further means to maximize synergy effects, from sample preparation and characterization to novel experiments and their interpretation and modeling.
- **Standards and protocols:** It clearly emerged from the discussion that the field of nanospectroscopy could benefit substantially from the establishment of a set of standards, benchmark systems and experimental protocols; this assessment was shared by partners from both academia and industry, especially when it comes to well-defined test samples to characterize the performance of probes for near-field optics and tip-enhanced microscopy/spectroscopy.
- **Improving tip fabrication:** The WG members agree on the importance of improving tip fabrication in terms of geometry, coupling efficiency, reproducibility and quality control, production yield, and cost; this issue is equally important from the point of view of the commercialization of probes as well as for fundamental research.
- **Performance of nanospectroscopic techniques:** Resolution (spatial and spectral), sensitivity and specificity were identified as the most fundamental figures of merit, but it was also pointed out that speed, throughput, scalability, and reproducibility are becoming increasingly important, especially for the commercialization of nanospectroscopic instrumentation. Further issues brought up in the discussion were the availability of sources, filters and sensitive spectrometers/detectors in all pertinent spectral domains (UV, visible, NIR, THz), as well as the desirability of moving towards integrated, single-bench instruments allowing for the combination of different techniques, for both bulk studies and at the level of individual nano-objects.
- **Interpretation of experimental results**, as well as modeling interactions and techniques, are considered crucial, which is why many members of WG 3 are also involved in WG 2 (Physical Processes and Modeling).
- **Commercialization of nanospectroscopic devices:** Partners from the private sector identified finding a suitable market segment as a major challenge in commercialization; adopting an integrated approach allowing for customization and combining hardware with services and expertise/consulting were mentioned as viable business strategies.

Technical expertise and scientific interests in WG3

Below an overview over the technical expertise and scientific interests of the members of Working Group 3 is given, organized by techniques, interaction mechanisms and systems of interest:

Techniques:

- confocal, wide-field, and dark-field microscopy
- interferometric techniques, holography, polarization
- scanning tunneling microscopy
- near-field microscopy, tip-enhanced microscopy
- electron microscopy, electron energy-loss spectroscopy
- time-resolved microscopy, coherent control
- atomic force microscopy
- nonlinear optical microscopy (second harmonic, sum-frequency, third harmonic, multiphoton)
- correlation spectroscopy
- functionalized probes
- optical traps, tweezers, manipulation, biosensing
- super-resolution (localization) microscopy
- tailoring focal field distributions

Interaction Mechanisms:

- absorption (photothermal detection), reflection, extinction, scattering, fluorescence
- tip- and surface-enhanced Raman scattering, low-frequency Raman scattering
- electroluminescence and electro-optics, magneto-optics
- linear and nonlinear optics and plasmonics
- electron scattering and diffraction
- thermochromism

Systems of Interest:

- metal (Au, Ag, Al) nanoparticles (clusters, spheres, rods, disks, rings, cones, bumps, stars), core-shell particles, alloys
- organic chromophores (mono-, oligo-, polymers, aggregates, crystals)
- natural light-harvesting complexes, photosynthetic proteins, autofluorescent proteins
- organometallic complexes
- semiconductor quantum dots, wells, wires, pillars, metal chalcogenides
- DNA (templates), proteins, lipids, membranes, cells, biomimetic structures
- carbon allotropes
- surfaces and thin films, layers, sub-wavelength apertures, arrays, resonators, gratings
- hybrid nanostructures
- magnetic nanostructures