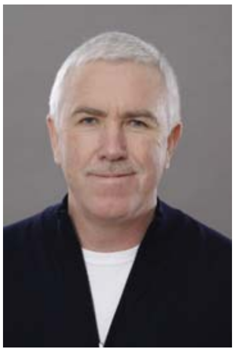


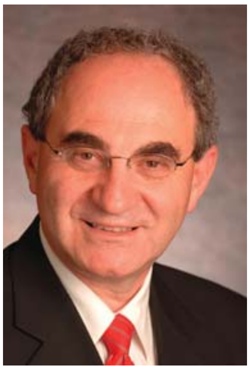
3D Laser printing of nanoparticles and living cells

Boris Chichkov
Institut für Quantenoptik, Leibniz Universität Hannover and Laser Zentrum, Germany
11:20-11:55

Laser printing can be used for printing very small and delicate objects like nanoparticles and living cells. Nowadays, 3D printers can be bought for less than 500 Euro. They are able to print three-dimensional structures from thermoplastic and other materials. Here we report on laser printing of nanoparticles and living cells.

We demonstrate a simple printing method allowing the generation and arrangement of spherical metal and dielectric nanoparticles in a very precise manner. For example, the printed silicon nanoparticles have a predefined size and are characterized by unique optical properties. With sizes in the range of 100-200 nm in diameter they exhibit pronounced electric and magnetic dipole resonances within the visible spectral range. Fabrication, characterization, and applications of the generated nanoparticle arrays will be discussed.

In a series of publications on laser printing of living cells we proved that cells are not harmed by the printing process. The differentiation behavior and potential of laser printed stem cells are not affected. Stem cells can be printed in defined patterns and then differentiated within these patterns towards bone, cartilage or adipose tissue. With specific multi-cellular cell structures, studies of cell-cell and cell-environment interactions can be performed. Furthermore, fibroblast and keratinocyte cells have been printed layer-by-layer to form 3D skin tissue constructs. The skin tissue formation has been proven by visualizing intercellular junctions and verifying their functionality. The presented laser printing techniques are promising for a wide range of applications in nanophotonics and tissue engineering.



Why We Need To Replace the Transistor, and What Would be the Newly Required Material Properties?

Prof. Eli Yablonovitch
University of California, United States
11:55-12:30

In contemplating the headlong rush toward miniaturization represented by Moore's Law, it is tempting to think only of the progression toward molecular sized components. There is a second aspect of Moore's Law that is sometimes overlooked. Owing to miniaturization, the energy efficiency of information processing has steadily improved. But there is an inefficiency for internal communications in a chip. It is caused by the difference in voltage scale between the wires and the transistor switches. Transistors are thermally activated, leading to a required voltage >>kT/q. Wires are long, and they have a low impedance, allowing them to operate efficiently even at a few millivolts. Thus the main Figure-of-Merit for future transistors is low operating voltage or sensitivity, NOT mobility.

The challenge then is to replace transistors with a new low-voltage switch that is better matched to the wires. I will present the new material quantum level properties, which are being explored by the NSF Science & Technology Center for Energy Efficient Electronics Science.

Applications of plasmonic and dielectric nanoantennas in nanophotonics

Stefan A Maier
Imperial College London, UK
12:30-13:05

Optical nanoantennas based on metallic nanostructures enable the controlled focusing of light from the far field to highly confined volumes below the diffraction limit, and furthermore form the basis of implementations of metamaterials and metasurfaces operating in the optical regime of the spectrum.

Upon excitation of the plasmon oscillation, parts of the energy get dissipated via elecron/hole pair formation, leading ultimately to dissipation into phonon modes. Here, we show how the vibrational frequencies of these modes can be controlled on the nanoscale, at the level of an individual nanoantenna. This is achieved via pinning certain parts of the antenna stronger to the substrate, utilizing oxide bar layers. Comprehensive finite element modelling combined with degenerate fs pump probe spectroscopy allows us to determine the ratio of the amplitudes of the underlying vibrational normal mode, demonstrating the tailoring. We believe that this work could be the start of a new avenue for control over electromagnetic - acoustic coupling in optical metasurfaces.

We further demonstrate the mapping of plasmonic hot spots using super-resolution far-field fluorescence spectroscopy, including a de-coupling of enhanced absorption and emission processes. The crucial role of the latter in determining the position of the emitter with respect to the antenna will be elucidated. Finally, we will present applications of dielectric nanoantennas for surface-enhanced spectroscopies, including antennas operating via localized surface phonon-polarion modes.