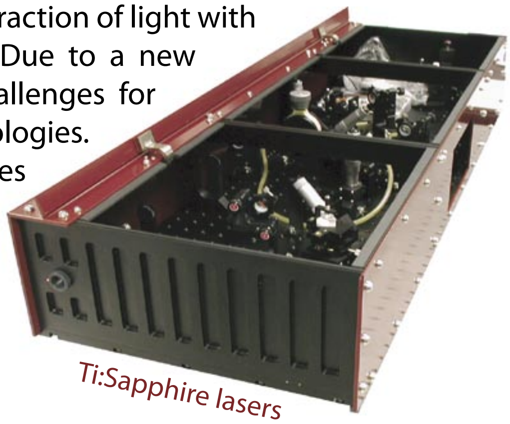
Femtosecond Nanophotonics

Del Mar Photonics inc. is an established manufacturer and system integrator of advanced photonics products for scientific and industrial applications introduces the ultrafast laser oscillators and amplifiers based on Ti:Sapphire, Cr:Forsterite, Er- and Yb- doped fibers that are suitable for your nanophotonics investigations.

Nanophotonics is a new frontier that deals with the interaction of light with matter on a scale shorter than the wavelength of light itself. Due to a new dimension to nanoscale science, nanophotonics provides challenges for fundamental research and creates opportunities for new technologies. It is a field that comprises physics, chemistry, applied sciences and engineering, biology, and biomedical technology.



Ti:Sapphire lasers

Nanophotonics can be divided into three major parts. The first part is nanoscale confinement of radiation, confining light to nanoscale dimensions that are much smaller than the wavelength of light (near-field optical propagation).

Cr:Forsterite lasers

The second part is nanoscale confinement of matter, thereby limiting interactions between light and matter to nanoscopic dimensions. This defines the field of nanomaterials. The most popular area of nanomaterials is a photonic crystal that represents a periodic dielectric structure with a repeat unit of the order of wavelength of light.

The third one is nanoscale photoprocesses, are used to induce photochemistry or light-induced phase change. It can be used for nanolithography to fabricate nanostructures.

Those nanostructures that involve optical modes at the interface between metallic and dielectric materials have attracted increasing attention. They exhibit intrinsic field localization at the interface. The localization of the field facilitates nanoscale waveguiding and has shown potential for full optical confinement within the nanostructure waveguides. In this case the average power requirements for nonlinear wave mixing is significantly reduced. Furthermore, the unique features of surface plasmonic fields could lead to photonic devices that are much more compact.

Fiber Lasers

Ultrafast lasers and instruments are used in nanophotonics to study dynamics of different nano-objects. Dr. Fainman et al. from University of California, San Diego (UCSD), long time customer of Del Mar Photonics Inc., investigated the excitation and visualization of ultrafast dynamics of surface plasmon polarization (SPP) modes by coupling the optical field into and out of the metallic film using a 3D array of nanoholes etched in the metallic film on a dielectric substrate.

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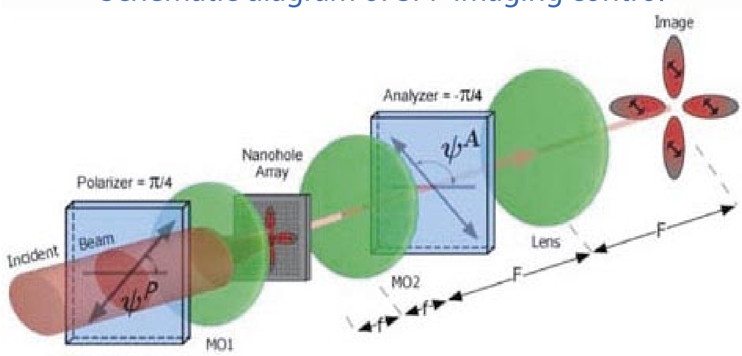
When a plasmon wave is coupled between the photon and the electron gas, there is an effective binding energy that prevents coupling of a free space photon to the SPP in normal circumstances.

Fainman's group constructed a laser-illuminated SPP imaging apparatus to understand the excitation and propagation process of the resonant modes. By introducing a polarizer-analyzer pair to control the polarization state of the excitation field and the field in the image plane, they performed the excitation using a focused laser beam at normal incidence.

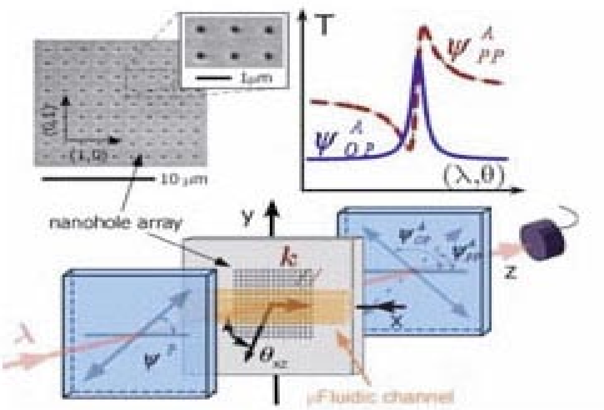
Schematic diagram of SPP imaging control



A sample is illuminated using a focused laser. The resulting SPP mode is then imaged onto an InGaAs CCD array via a 4F imaging system.

By using time-resolved imaging (the reference optical pulse, divided from the same laser, is combined on the surface of the CCD with the image of the nanhole array scattering the femtosecond SPP pulse), they investigated the connection between spatial and temporal characteristics of the incident optical waves and of the excited and scattered SPP waves. In addition, they developed a high spectral resolution surface plasmon resonance SPR sensor that operates at normal and near normal incidence, facilitating high resolution imaging.

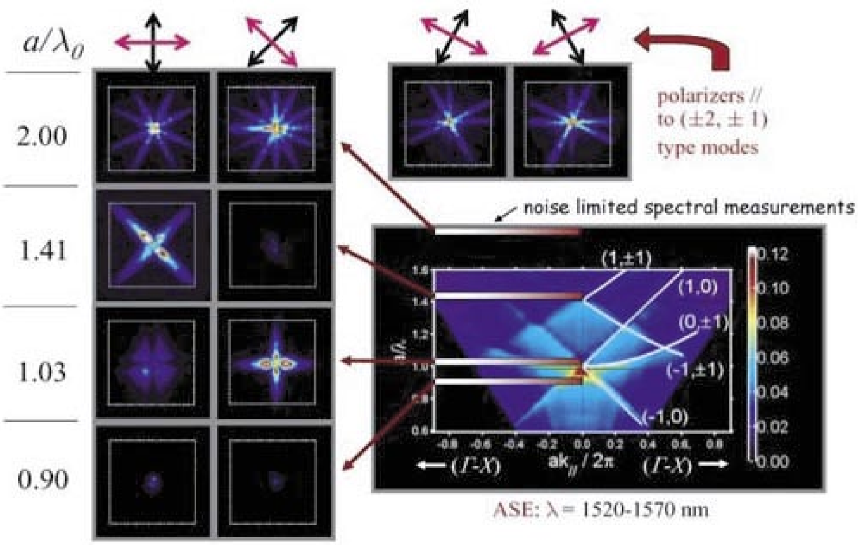
The 2D nanohole array-based sensor



A microfluidic channel transports the analyte fluid to the surface of the sencing area

The ultrafast SPP combined with opto-fluids will have a significant impact on various applications, including nanometrology, nanoscale spectroscopy, live cell dynamics, sensing hyper-spectral imaging of biological species and nanotomography.

Spectral measurements of unpolorized zero-order transmittance



Measurements for cubic arrays of holes in aluminum film on glass substrate. The stitching frequencies appear as horizontal black lines. The SPP images were obtained using four samples .Images of the higher order SPP modes obtained with laser illumination of nanohole arrays.

Del Mar Photonics offers integration of femtosecond laser systems for research of ultrafast dynamics in nanophotonics, as well as multiphoton imaging, scanning probe microscopy, micromachining, ultrafast fluorescence kinetic and transient pump-probe absorption spectroscopy systems.

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