Abstract:

Surface-plasmons polaritons (SPPs) can be used to confine electromagnetic radiation at visible and near-infrared frequencies within sub-wavelength mode volumes. This makes SPPs an interesting prospect for data storage applications [1] and micro/nano-optics for telecommunications, making them the focus of intense research activity. However, optically exciting SPPs in a compact device has proved challenging [2,3] due to the necessity of providing the missing momentum between free photons and the SPPs of the same frequency. We demonstrate such an electrically pumped devices for the generation of SPPs based on a semiconductor quantum cascade laser.

Two approaches have been investigated. In the first one, a SPP mode is directly excited in a metal/air interface using a mid-infrared QCL dry etched facet output. In this case, we demonstrate the SPP generation and propagation via mid-infrared imaging, using a metallic diffraction grating and a micro bolometer imaging camera to probe the SPP propagation. SPP generation and launching has been also proved by near field imaging. Figure 1a shows a schematic cross-section of our device. A standard quantum cascade laser (QCL) is used to generate transverse magnetic (TM) polarized mid-infrared light. A gold strip is placed close to the output facet of the semiconductor laser and the laser output is directly coupled to the SPP modes on the gold/air interface. A diffraction grating is then superposed further along the gold strip in order to couple the localized evanescent SPPs to an external sensor via the far filed emission.

Figure 1: (a) Schematic cross section of the device. A gold strip is deposited close to the dry etched QCL facet. A metal grating on the SSP-carrying strip scatters the SPPs, thus permitting their far-field observation. (b). Scanning electron microscopy images of a processed device.

We investigate a second approach to generate and launch SPPs. We used a first order distributed feedback metal grating on top of a mid-infrared SPP-QCL [4]. A coupling grating is used to couple the evanescent localized surface device light to the SPP mode of a metal/air interface. For both approaches, we use an aperture-less near-field scanning microscope (a-SNOM) [5] to directly observe the generated SPPs.

4-References: