Controlling the optical field down to the nanometer scale is a key step in optoelectronic applications and light matter interaction at the nanoscale. Bowtie structures, rods and sharp tapers are commonly used to realize such optical properties, but their fabrication is challenging. In this context, the complementary structures, namely holes and cavities, are less explored. Herein, a simple system of two metallic nano-cavities milled in thin silver film is used to confine the electromagnetic (EM) field to an area of ~60nm$^2$. The field is confined onto a flat surface area and is either enhanced or suppressed by the polarization state of incident light. The energy of this spatially confined mode is determined by the distance between the two cavities and thus any color (wavelength) at the optical regime can be achieved. As a consequence, a dynamically controlled color is generated on an optical pixel size smaller than one micron square. Those results are supported both by transmission spectra and a Cathodoluminescence study.

Figure 1.

a. Recorded MonoCL intensity map of the coupled system (in 365-395nm wavelength region), with the confined mode between the two cavities clearly observed.
b. Transmission micrographs of dimeric nano-cavities structures with various inter-cavity distances. Top left - HR-SEM image of a pair of triangular cavities with an inter-cavity distance $d$. Top right - Optical transmission micrographs of six dimeric structures differentiated only by their inter-cavity distance. The micrographs are taken under white light linearly polarized along their interaction axis. The observed colors span over the whole optical range, in sharp contrast to the case of orthogonal polarization shown in the bottom micrograph, in which only red-orange colors are observed.

c. The coupled plasmonic system. The broadband plasmonic modes excited at the triangular edges propagate onto the silver surface. The two nano-cavities act as a broadband source of surface plasmons which interfere constructively and therefore enhance specific modes with relation to the inter-cavity distance $d$. The colors generated by this coupled plasmonic system are therefore determined by the properties of the single nano-cavity and the distance between the cavities.

References: