Probing ultra-fast nearfield dynamics of individual nano bowtie-antennas

E. Lorek[1], E. Mårsell[1], A. Losquin[1], M. Miranda[1], A. Harth[1], C. Guo[1], R. Svärd[1], C. Arnold[1], A. L'Huiller[1], A. Mikkelsen[1], and J. Mauritsson[1]

[1] *Department of Physics, Lund University, Lund*

Presenting Author: eleonora.lorek@fysik.lth.se

By illuminating nano antennas with light, and excite collective electron oscillations known as plasmons, light can be focused down to below the diffraction limit and be greatly enhanced. For many applications of such antennas the near-field and its temporal aspects are relevant. The optical techniques capable of characterizing the ultrafast optical far-field response from micro- and nanostructures in time ([1],[2]) face the diffraction limit.

Photoemission electron microscopy (PEEM) combined with fs laser pulses and optical interferometry has, however, been demonstrated as a powerful tool in probing laser induced near-field dynamics with nanometer spatial resolution [3]. We apply the technique, using 6 fs, 800 nm central wavelength pulses from a Ti:Sapph oscillator, to nano bowtie-antennas of gold. Varying the size of the antennas during the fabrication process (Figures 1 a, b) allows for tuning their response to the excitation field (Figure 1 c). Changes in their ultrafast response are recorded with the PEEM, laser and interferometer as differences in the resulting near-field autocorrelation traces (Figure 1.d) from the different antenna sizes. Combined with an accurate characterization of the incoming pulses, the results are compared to Finite difference time domain numerical simulations.

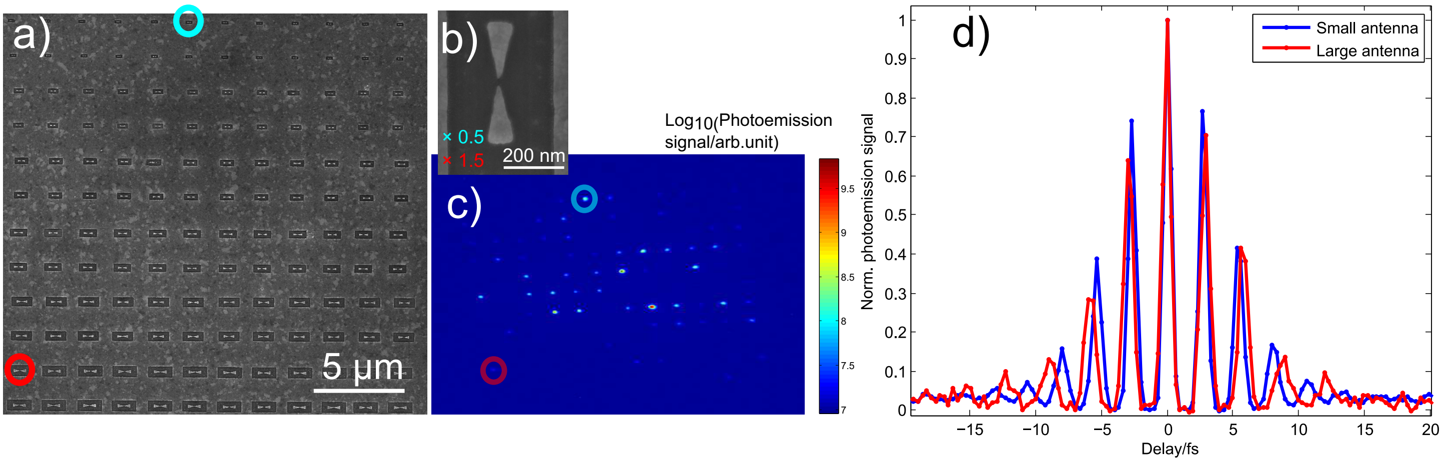

Figure 1: *a) A Scanning electron microscopy image of an array of bowtie antennas that vary in size. One small (blue) and one large (red) bowtie are marked in the image. b) The dimensions of the bowties. The small bowtie has the dimensions in the image scaled by a factor of 0.5 and the large one has the dimensions scaled by 1.5. c) A laser PEEM image showing the photoemission spots resulting from field enhancement at the gap of the antennas. d) The photoemission signals as a function of pulse delay (the near-field autocorrelation traces) for the two antennas selected.*

References

[1] A. Andersson *et al.* Nano Lett. **10** 2519 (2010)
[2] N. Accanto *et al.* Nano Lett. **14** 4078 (2014)
[3] A. Kubo *et al.* Nano Lett. **5** 1123 (2005)