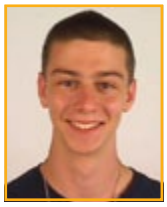
Control of the emission properties of semiconducting nanowires using plasmonic nanoantennas



Principal investigators

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Laboratories: NEEL, INAC

We aim at studying and evidencing plasmonic effects sustained by metallic nanoantennas onto a semiconducting nanowire to explore their potential for modifying/enhancing/orienting its emission. The project combines numerical simulations of different emitter-nanoantenna assemblies, developing strategies for fabricating such systems, and carrying out the optical studies of these devices. To achieve these goals we use the state of the art technical facilities in nanofabrication and nanocharacterization available within LANEF.

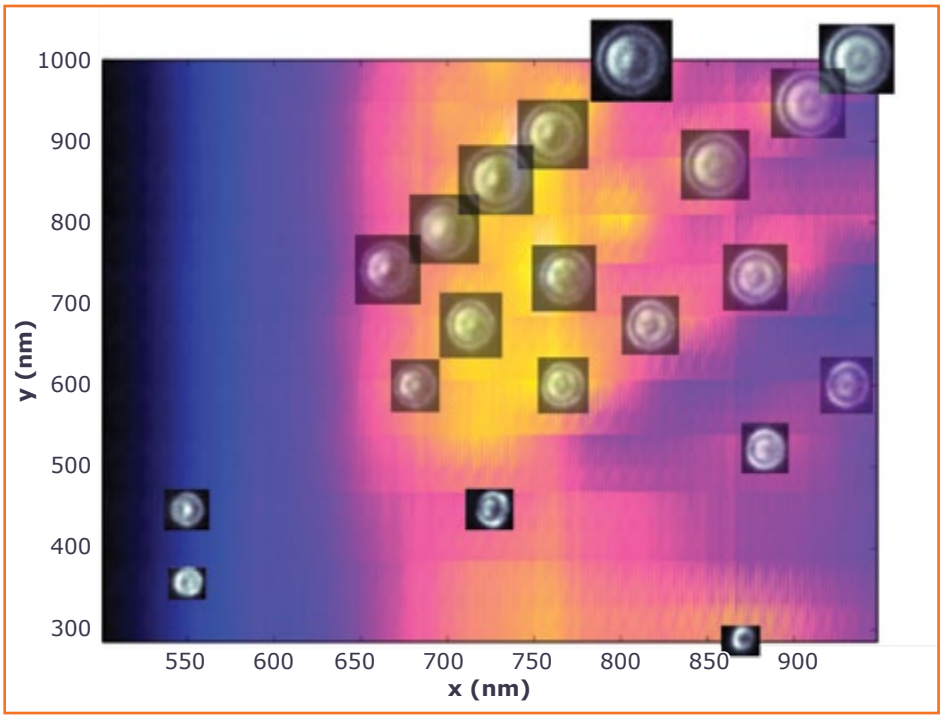
Description

Plasmonic nanoantennas are metallic particles that bear broadband, low-Q resonances in a part of the electromagnetic spectrum. Relying on localized surface plasmon, they feature a sub-wavelength confinement of the electromagnetic field. They are extremely sensitive to near optical field distribution, and coupling them to nanoscale emitters such as nanowires (NWs) requires an extreme precision.

A first part of the project has been to develop characterization tools for a precise study of nanowires and nanoantennas. Using cathodoluminescence, we were able to find the localized plasmon resonance of plasmonic antennas, as well as to image their local density of optical states, to describe the coupling properties with nearby emitters. We also implemented a spectroscopy setup allowing for Fourier imaging and time-resolved photoluminescence characterization of the nanowires.

Coupling this with cathodoluminescence characterization allowed us to completely characterize isolated nanowires of several materials (III-V: GaAs-AlGaAs and GaN-AlGaN core-shell nanowires; II-VI: CdTe quantum dots in ZnTe NWs).

We subsequently developed novel nano-fabrication techniques using electron-beam lithography allowing nanoantenna fabrication, nanowire localization and re-alignment of lithography setup over previously characterized nanowires. Our current work now relies on the effective implementation of the coupled devices, a plasmonic dimer patch antenna coupled to a nanowire.



Cathodoluminescence emission spectra of plasmonic antennas (x : wavelength, y :antenna size) .
One observes different branches corresponding to different modes whose structure is mapped in the insets.

Collaborations : with Guillaume BACHELIER (NEEL), Fabrice DONATINI (LANEF TREE project page 7).

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