Experimental manufacture-modelling and characterization of of hyper-lensing properties of hyperbolic metamaterial

Background

A *metamaterial* is an *artificial "designed" material* with properties nominally not found in nature. However, the negative index Vesalago superlens described in detail by Pendry, turns out to be quite difficult to manufacture. The *hyperbolic metamaterial* is basically an artificial uniaxial effective medium with certain properties that allow for propagation of so-called evanescent waves with *high spatial frequency*, and is more easily fabricated. The high spatial frequency components are not detected in normal imaging (they are filtered by propagation), and are hence responsible for the poor performance of the optical microscope – i.e. the *Rayleigh criterion*. On the other hand, the detection of these high frequency components results in principle in high contrast high resolution imaging, i.e. the so-called *hyperlens*.

Student Project Description

The student will in this project study the properties of hyperbolic metamaterials. In this project, we will initially manufacture thin film stacks of ultrathin metallic and dielectric layers on transparent substrate. The experimental work will be to develop a prism configuration to study by spectroscopic ellipsometry the near field evanescent waves picked up and turned into propagating modes by the hyperbolic metamaterial, and further conveyed to the optical detector.

Depending on the interest of the student, the project may involve both COMSOL simulations of the propagation through the hyperbolic material, and analysis (mainly linear algebra) related to the dispersive properties of

Responsibilities and skills

The student must be interested in linear algebra, thin film manufacture, and electromagnetics . The student must be interested in working partially in the NTNU nanolab for the thin film manufacture. Hence it will be obligatory to follow the nanolab clean-room course, and the related courses for the deposition of the thin films. The student must also be interested in learning to perform spectroscopic (Mueller Matrix) Ellipsometry, and designing flexible geometries for characterization.

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