Enhanced second-harmonic generation in AlGaAs nanoantennas

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Introduction: The optical response of sub-wavelength size dielectric particles can exhibit both strong electric and magnetic optical resonances in the visible and near-IR wavelength range [1]. These optical properties make all-dielectric nanoantennas a unique opportunity for the study of nonlinear optical effects generated from both electric and magnetic resonances [2].

Computational Methods: We investigated the optical scattering of Al₀.₁₈Ga₀.₈₂As cylinders at near-IR wavelengths by using Frequency Domain (FD) simulations in the Wave Optics Module of COMSOL. The scattered field was finally decomposed using a multipolar expansion [3].

In order to investigate the SHG phenomenon, we used the nonlinear polarization induced by \( \chi^{(2)} \) of [\100\] Al₀.₁₈Ga₀.₈₂As as a source in subsequent FD simulations:

\[
\eta_{SHG} = \frac{\int S_{SH} \cdot n \, da}{I_0 \times \pi r^2}
\]

is maximum for a pump wavelength of \( \lambda = 1675 \text{ nm} \) (Fig. 4). This is due to a mode at the SH wavelength with good spatial overlap with the pump mode.

The peak wavelength of SHG efficiency red-shifts as the cylinder radius is increased (Fig. 5).

Conclusions: We reported the design of AlGaAs nanoantennas with a SHG efficiency larger than \( 10^{-3} \) from a single nanodisk.

References: