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A non-linear material interpolation for design of metallic nano-particles using topology optimization

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Abstract

This paper discusses a non-linear bi-material interpolation scheme for the relative electric permittivity, ϵ_r, through the refractive index and extinction coefficient. The scheme is tailored for density-based topology optimization of metallic micro- and nano-structures, in electromagnetic problems in the optical wavelength regime. The scheme is shown to exhibit superior properties in the ultraviolet to low infrared wavelength regime, compared to simple linear and inverse interpolation schemes for ϵ_r used in the literature. The superior properties are demonstrated with optimization examples and a physical motivation is provided. Finally, the capability of the scheme is demonstrated by designing a nano-scale Ag antenna-strip providing approximately a 1200 fold spatially-localized enhancement of the electric energy, corresponding to a more than 600% performance improvement over a topology optimized reference design from the literature.

Keywords: material interpolation, electromagnetism, plasmonics, topology optimization, nano-antenna, nano-scale

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