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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,  $\epsilon_r$ , 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  $\epsilon_r$  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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