# Fast Evaluation of Refractive Index with Machine Learning

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**Abstract**— Evaluation of refractive index is a non-trivial process for anisotropic and dispersive materials. Broadband and polarization-dependent reflectance and/or transmittance data obtained using a single sample is not adequate to solve this non-linear problem. Experiments need to be conducted on multiple samples either with different thicknesses or different substrates. If one tries to solve this numerical problem via a simple search algorithm with a typical personal computer, it probably takes weeks if not months.

The aim of this work is accelerating this refractive index determination process via machine learning (ML). To achieve this, first, a training set is created, which includes broadband optical reflectance from 40 different materials with various thicknesses assuming different excitation angles. Materials were chosen from different groups, i.e. metals, semiconductors, and dielectrics. Then, machine learning is used for two different purposes: classification and regression. With classification, the material type is determined so that an appropriate refractive index model can be incorporated, i.e. Lorentz-Drude model for metals, purely real refractive index for lossless dielectrics, and complex but smoothly changing index for the rest. Depending on the material type, either univariate or multivariate linear regression is used to determine the refractive index assuming the material is isotropic. An order of magnitude difference is observed between a typical search algorithm (i.e. fminsearch in Matlab) and developed method. Accuracy of the numerical results promises that machine learning techniques can indeed accelerate various techniques used in electromagnetics, optics, and geophysics.

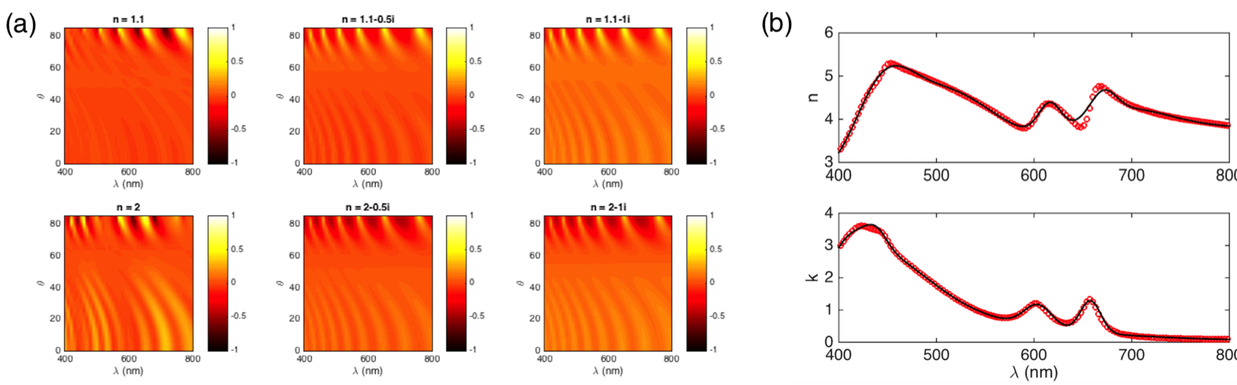


Figure 1: (a) Reflectance contrasts are calculated as functions of wavelength ($\lambda$) and incidence angle ($\theta$) for a broad range of complex refractive indices. (b) ML generated (black solid lines) vs. measured refractive index [1].

## REFERENCES

1. Mukherjee, B., "Complex electrical permittivity of the monolayer molybdenum disulfide (MoS2) in near UV and visible," *Optical Materials Express*, Vol. 5, No. 2, 447–455, 2015.