MOKE measurements were less sensitive to the distribution of particles size. Our calculations reproduce also the slightly different offset in wavelength (≈20 nm) between the ellipticity sign reversal and the rotation maximum observed experimentally upon crossing the polarization of the incoming light.

4. Conclusions

We developed a semi-analytic approach to compute the polarizability tensor of ferromagnetic ellipsoidal particles. Our approach, based on the Long Wavelength Approximation developed by Meier, Wokaun and Liao, has been extended to general ellipsoidal particles $a_x \neq a_y \neq a_z$, with a_x, a_y and a_z the semi-axes of the ellipsoid, including also magneto-optical coupling and dynamic depolarization corrections to account for particles size. The dynamic depolarization corrections are essential in order to well reproduce the experimental spectra, given that the typical sizes of ferromagnetic nanostructures used in most of the experiments conducted in the visible and near infrared spectrum are in the 100 – 300 nm range, viz., exceeding the Rayleigh limit. Furthermore, in order to compare our model outputs against real magneto-optical experiments, measured in reflection geometry and using a large number of particles, we calculated reflectivity spectra using a Maxwell-Garnett Effective Medium Approximation combined with the Transfer Matrix Method. To investigate the prediction of our model, we performed a side-to-side comparison between our calculations and magneto-optical spectra measured in polar configuration on nickel nanodisks deposited on a glass substrate with circular and elliptical shape and sizes of 100 and 160 nm. The disks were modeled as ellipsoids for which the polarizability tensor was computed using our approach. Such disks support localized plasmon resonances in the visible spectrum region, which in turn are responsible for salient spectral features in the magneto-optical spectra. The calculations performed with our formalism are in excellent quantitative agreement with the experimental measurement, with no other parameters than material dielectric optical and magneto-optical constants (taken from literature), and nanostructure sizes and shapes (experimentally determined). We also demonstrated the fundamental role of the dynamic depolarization term when the nanostructure size beyond the Rayleigh limit. This term, often neglected in most of literature magneto-optical studies so far, has to be included in order to obtain realistic approximation of the experimental evidence. Finally, these results demonstrate that our approach, in spite of its approximations, captures the essential physics of the interplay between magneto-optical activity and excitation of localized plasmon resonances in single magnetic nanostructures, optically non-interacting, of broad fundamental and practical interest. For disk-shaped nanostructures, for which our results show that their approximation to ellipsoids works remarkably well, our methodology is accurate and provides an easy alternative to numerical simulations, at least for the case of optical non-interacting magnetoplasmonic particles.

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