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Characterisation of co-existing circular and linear Bragg resonances in helically sculptured thin films

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Helically sculptured thin films have been an interesting topic in applied optics; mainly because of their controlled optical properties such as optical activity and they can be fabricated by almost any material. These thin films were made by glancing angle deposition (GLAD) which allows us to control the orientation of the substrate during the deposition allowing the helical nanostructure. If the incident light's wavelength is the same as the helix pitch of the film, due to their chiral structure, these films reflect circularly polarized light with the same spatial handedness of the film's helix at a fixed time. This well-known phenomenon is called the circular Bragg resonance and it can be observed at any angle of incidence.

When the incidence angle is different than 0°, we have found a second peak at twice the circular Bragg resonance wavelength and it has been confirmed with simulations. We have analysed the optical properties of the film by calculating the eigenvalues and eigenvectors of the Jones matrix of the reflection spectrum in the visible and near IR spectrum for various incidence angles and azimuth angles. We were able to conclude that the eigenmodes around the wave band of the second peak are almost linearly polarized with diagonal and anti-diagonal polarization states with respect to the plane of incidence. When the number of periods is increased, the reflectance approaches unity for both orthogonal polarization states in the neighbourhood of this resonance. However, the phase shift at reflection is different for each eigen polarization. This suggests that the second peak is a linear Bragg resonance. The inclination of the biaxial index ellipsoid of each monolayer lifts the degeneracy that exists between the layers rotated by 180° when the incidence angle is different from 0°: the periodicity thus becomes twice as large as at normal incidence, and this creates a second resonance at twice the wavelength.blank

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