From Positive to Negative Reflectance Response in Fibre Optics Tipped with Stacked Graphene/Dielectric Coatings

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Since its isolation [1], graphene has attracted plenty of attention as a strong candidate platform for future application in both electronic [2] and photonics devices [3]. Pristine graphene crystals can now be produced by mechanical exfoliation or chemical vapour deposition. Such methods are not appropriate for industrial manufacturing and graphene-oxide (GO) emerges as reasonable alternative [4], synthesised by simpler chemical processes. Recently, some of us [5] explored the possibility of coating an optical fibre's endface with stacked graphene/polyethylenimine films, in order to tune its internal surface reflectance.

Inspired by the previous experimental work, we present a theoretical modelling for a cleaved optical fibre with a termination coated by a stacked heterostructure of dielectric slabs separated by pristine graphene membranes (scheme in the inset of Figure 1). A study of the reflectance across an experimentally relevant spectral range is done using an optical transfer matrix method, for different parameters of the setup.

As our main result, we found an oscillatory modulation of the surface reflectance across the analysed spectral range, for number of graphene/dielectric bilayers around 10-50, with widths of a few tens of nm. Additionally, given a fixed coating, the amplitude of this modulation is shown to depend on the environment's refractive index, by either increasing (positive response) or decreasing (negative response) its surface reflectance at different wavelengths. Spectral regions of positive and negative response are separated by *"nodal points"*, where the surface reflectance is virtually insensitive to the environment. Additional studies for doped graphene membranes (simulating oxidation effects) and non-periodic (disordered) heterostructure revealed a strong robustness of these transition points to precise mesoscopic details. An example of this behaviour is depicted in Figure1.

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FIGURES

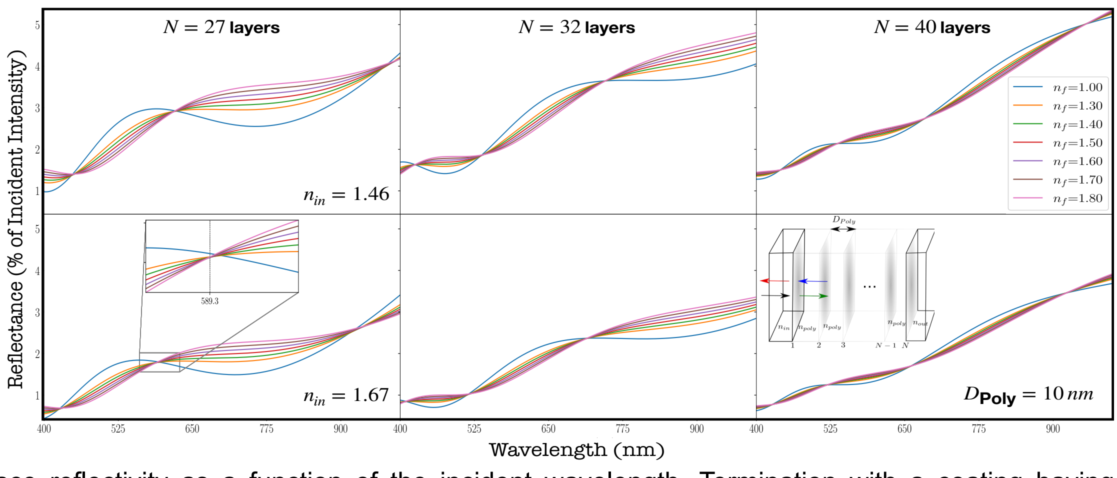

Figure 1: Surface reflectivity as a function of the incident wavelength. Termination with a coating having $N = 27, 32$ and 40 graphene/dielectric bilayers of constant width 10 nm are considered for different values of the environment's refractive index (n_f) in the range of typical fluids. The upper (lower) panels correspond to an optical fibre with an index 1.46 (1.67).