

# Optics of 2D materials

## Homework Assignment 2

1. Using matlab/python plot the dispersion relation  $\omega(\beta)$ , the propagation length  $L = \frac{1}{2\text{Im}(\beta)}(\lambda)$  and the penetration depth  $\zeta = \frac{1}{|K_z|}(\lambda)$  for Surface Plasmon Polariton (SPP) at a metal/dielectric interface. Use a metal with a permittivity from Drude model with  $\hbar\omega_p = 5\text{eV}$  and  $\hbar\gamma = 0.5\text{eV}$  for  $\hbar\omega \in [0, 10\text{eV}]$ , and a dielectric with  $\varepsilon = \varepsilon_0$ .
2. Using matlab/python plot the conductivity  $\sigma(\omega)$  of graphene, for Kubo and Local models. Use  $E_f = 0.3\text{eV}$ ,  $\hbar\gamma = 3.7\text{eV}$ ,  $T = 300\text{K}$  and  $\hbar\omega \in [0, 1\text{eV}]$ .
3. Solve analytically the dispersion relation of graphene plasmons, and reach the next equation:

$$\frac{\varepsilon_1}{\sqrt{q^2 - \varepsilon_1 \frac{\omega^2}{c^2}}} + \frac{\varepsilon_2}{\sqrt{q^2 - \varepsilon_2 \frac{\omega^2}{c^2}}} + i \frac{\sigma_g}{\omega \varepsilon_0} = 0$$