Exercise 8 (online: 19.06.2023. Return by: **Mo 26.06.2023 10:00**) **6P**

1. **Localized surface plasmon resonance shift sensor** 6P

   In the files n_air.txt, n_water.txt and n_polymer.txt you will find experimental data that was measured on gold nano-disc antennas (with a diameter of 165 nm, prepared on an ITO - glass substrate). Their dark-field scattering intensity was recorded while they were immersed in three different media: i) air (refractive index $n_{air} = 1.0$), ii) water ($n_{H_2O} = 1.33$), and iii) the polymer PMMA ($n_{PMMA} = 1.485$).

   The data provide the respective wavelengths and wavelength-dependent normalized intensities from which the sections of the three plasmonic resonance spectra in which the plasmon resonances are located can be analyzed.

   (a) Plot the spectra $I(\lambda)$ over the given wavelength range in the three different media in a single figure.(1P)

   (b) Fit the particle plasmon resonance peak in each spectrum with a Lorentzian function $f(\lambda) = \frac{c}{(\lambda-\lambda_{max})^2+(\frac{\gamma}{2})^2}$ (with a baseline of $I = 0$), using an interval of about $\pm 50\,\mathrm{nm}$ around the peak maximum as the fitting range. Plot these fits in three separate figures together with their experimental data.(2P)

   (c) Extract the resonance wavelengths of the peak maxima λ_{max} and the full-widths-at-half-maximum (FWHM) γ from the Lorentzian fit parameters and list them in a table.(1P)

   (d) Plot the three resonance wavelengths $\lambda_{max}(n)$ over the respective refractive index of the media (neglecting the refractive index of the substrate) in a new figure. Fit a linear regression line to the three data points and plot the linear fit in the same figure. The slope of this linear fit is the sensitivity S of the nano-disc sensor with $S = \Delta\lambda_{max}/\Delta n$. Write down S explicitly in the unit $\mathrm{nm/RIU}$ (refractive index unit).(1P)

   (e) Calculate the figure of merit (FOM) of this simple localized surface plasmon resonance (LSPR) shift sensor. The FOM is defined as the sensitivity divided by the FWHM at $n = 1$: $FOM = S/\gamma(n = 1)$.(1P)

   (f) Do a literature search to find an example of which FOMs have been realized in LSPR shift sensors in recent research. Attach a pdf file of the corresponding paper(s) and write down the value(s) of the FOM. If you have difficulties to download a paper, try connecting via eduroam or VPN. (2P, Optional)

   Hint: a selection of free software for plotting and fitting would be, e.g. gnuplot and python (freeware) or MatLab (free fur students via ZDV Software)