Understanding the reflectance of homo-polymers using White Light Spectroscopic Reflectometry

Ongoing Master Thesis

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Master Thesis Background

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CHESS Dec 17 and May 18

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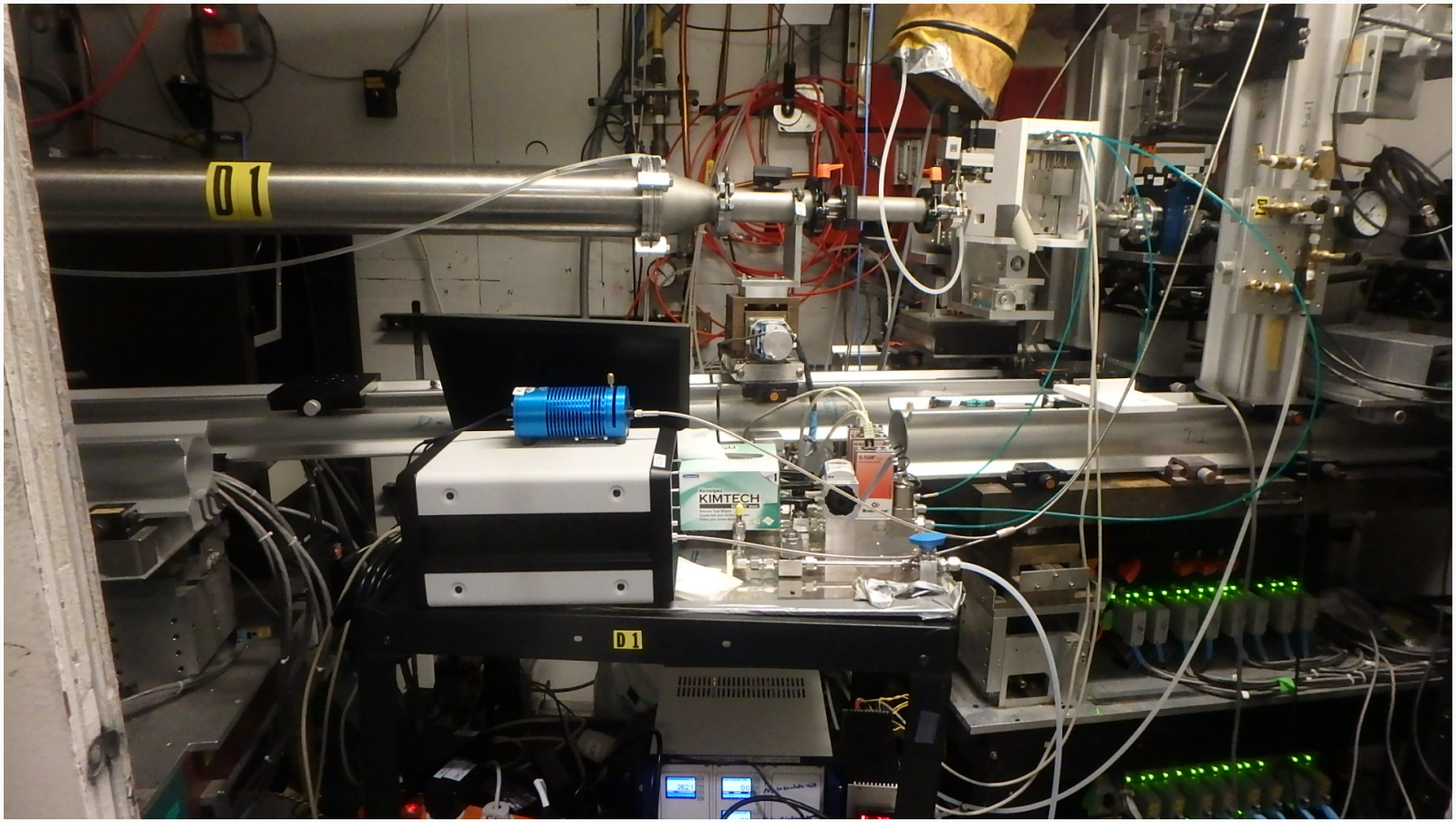

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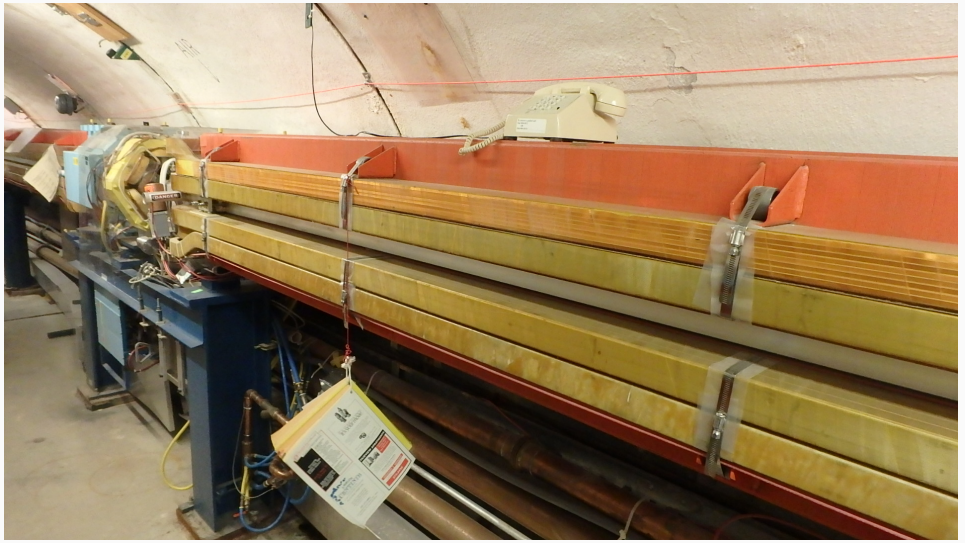
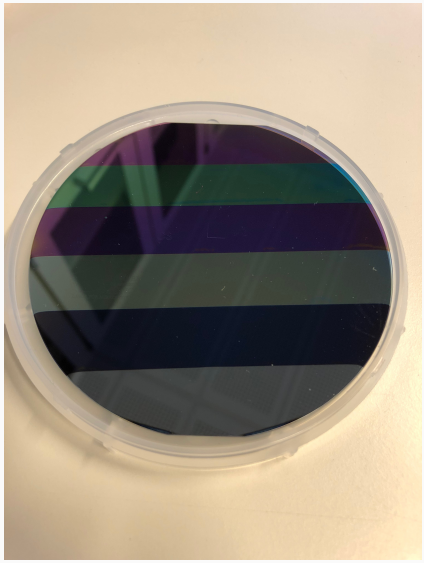


Thin Film Thickness

- Experimental techniques: Atomic Force Microscopy, Ellipsometry and x-ray reflectometry
- Spectroscopic Reflectometry
  - In-situ
  - Harsh environment
  - Small enough for test chamber and testing stage
- Complement GISAXS measurements

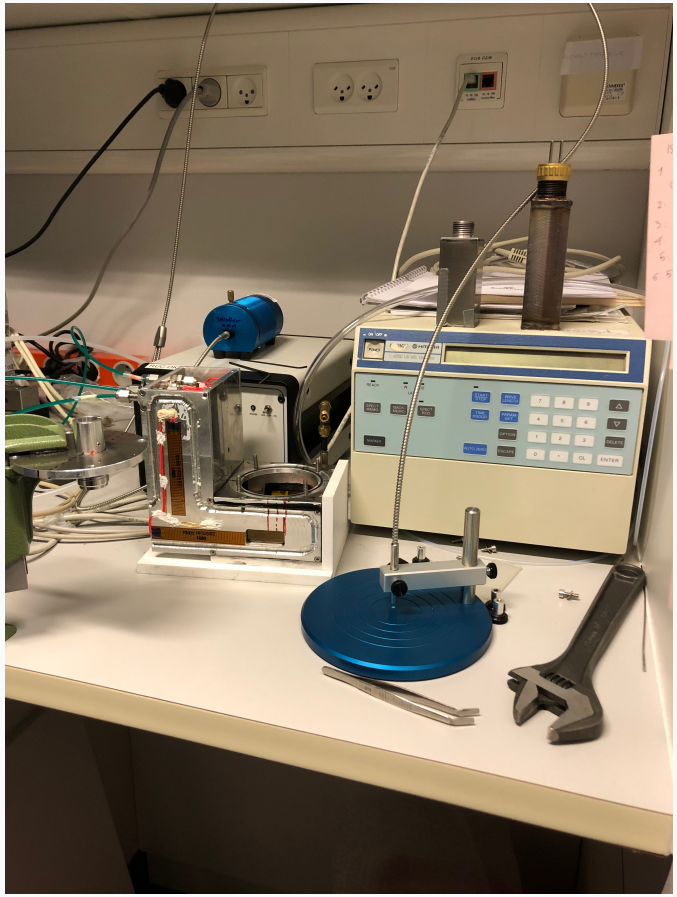


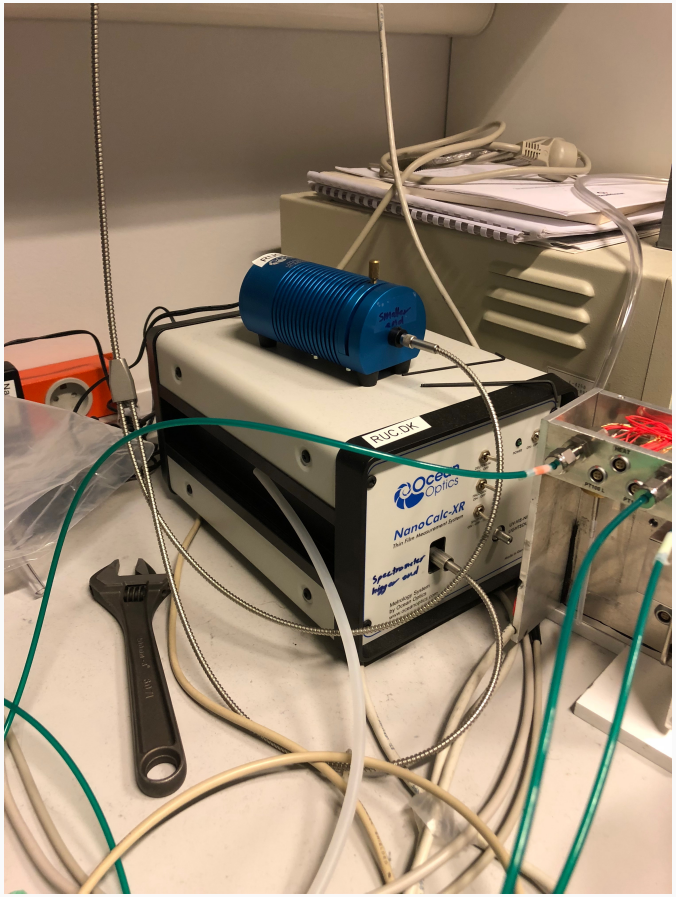
Problem Formulation

Experimental Setup

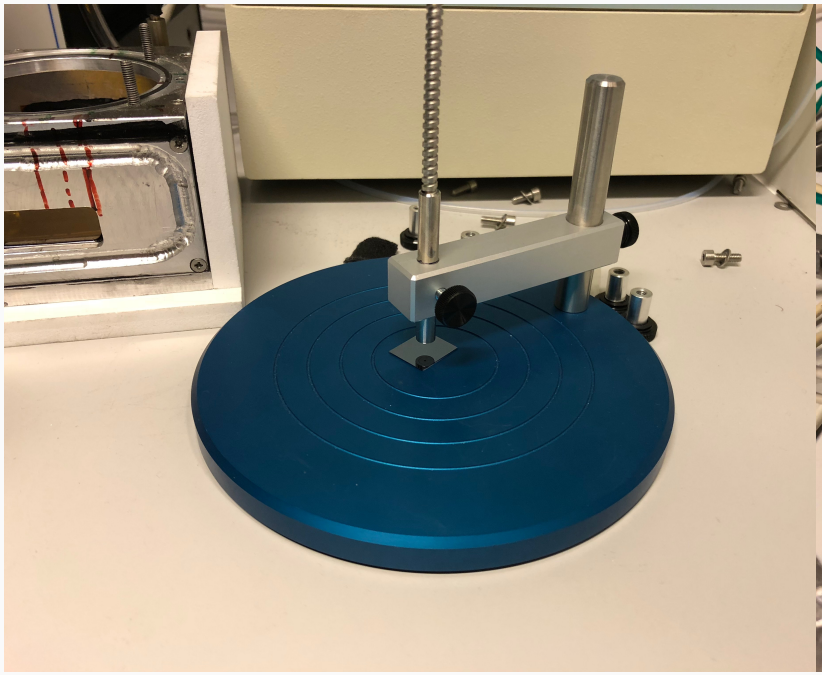
Components

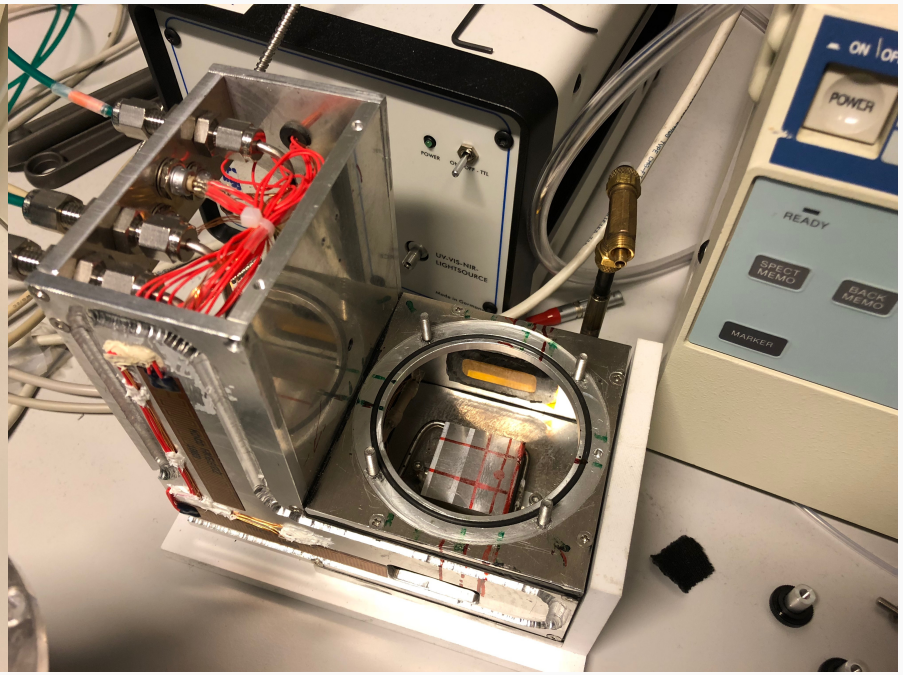
NanoCalc XR, Halogen Light Source, Test Chamber and Single Point Stage





Components Cont.





Light

What is it?

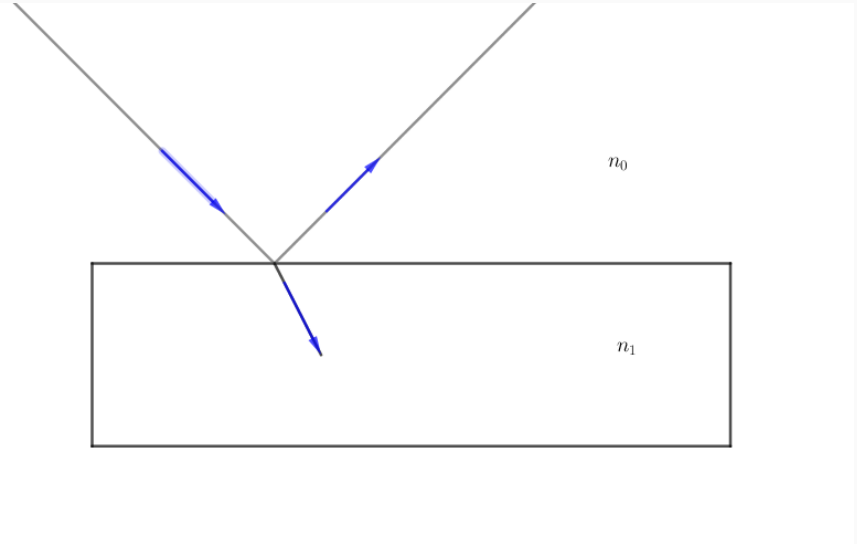
Electromagnetic Radiation

Preliminary Models

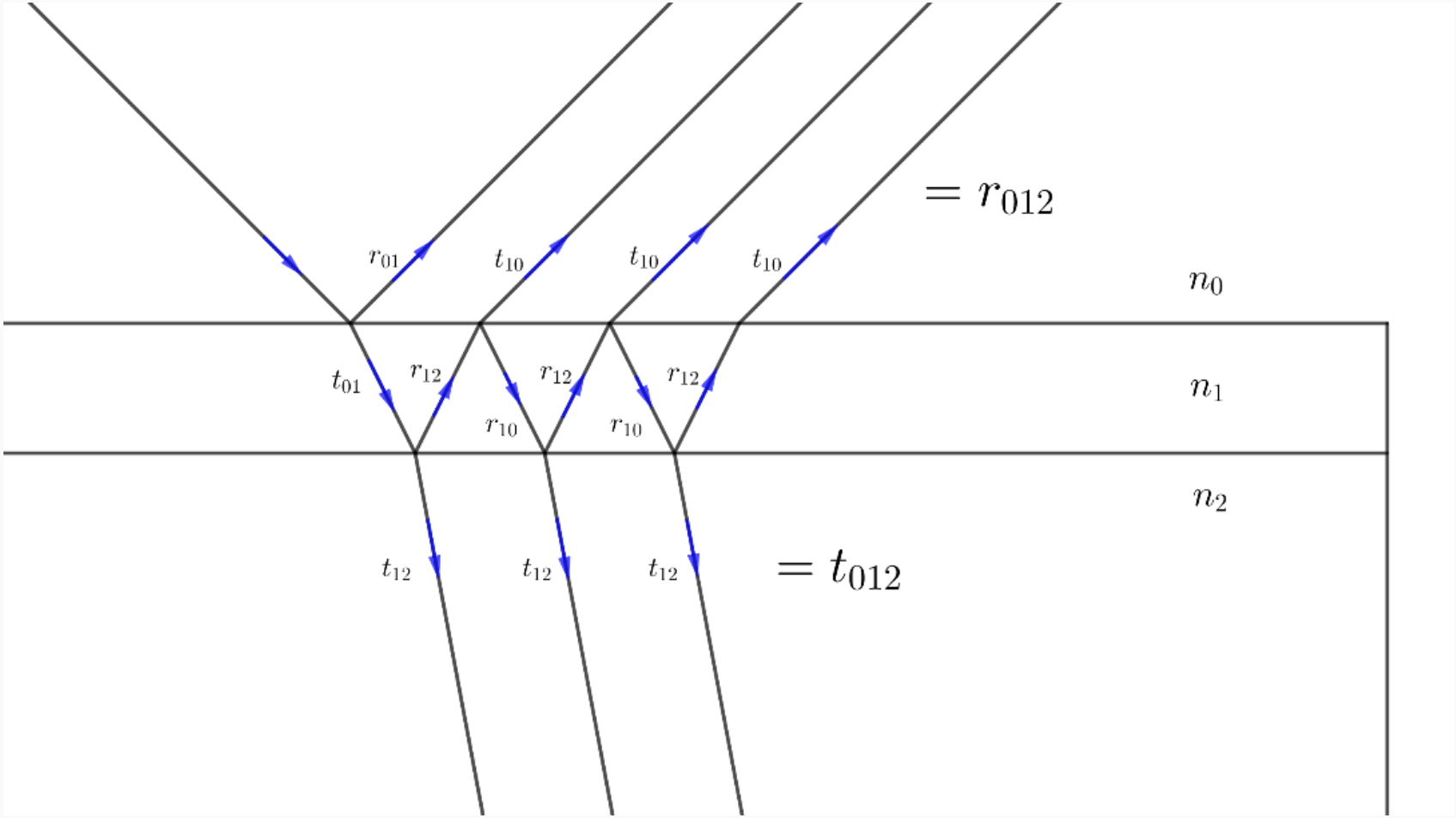
Fresnel Equations - Substrate

$$r_p = \frac{E_{r,p}}{E_{i,p}} = \frac{n_t \cos(\theta_i) - n_i \cos(\theta_t)}{n_i \cos(\theta_t) + n_t \cos(\theta_i)}$$

$$R_p = \mid r_p \mid^2$$



Fresnel Equations - One layer



$$r_{012} = r_{01} + t_{01}t_{10}r_{12}\exp(-i2\beta) + t_{01}t_{10}r_{10}r_{12}^2\exp(-i4\beta) + t_{01}t_{10}r_{10}^2r_{12}^3\exp(-i6\beta) + \cdots$$

Fresnel Equations - One layer

$$r_{012} = r_{01} + \frac{t_{01}\, t_{10}\, r_{12} \exp(-i2\beta)}{1 - r_{10}\, r_{12} \exp(-i2\beta)}$$

$$\beta = \frac{2\pi d_1}{\lambda} n_1 \cos(\theta_1)$$

$$r_{012} = \frac{r_{01} + r_{12} \exp(-i2\beta)}{1 + r_{01}\, r_{12} \exp(-i2\beta)}$$

Polymer refractive index dispersion

Cauchy empirical equation for the refractive index in the visible light range.

$$n(\lambda) = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4}$$

These constants can be found using ellipsometry.

Which dispersion to use? Can Cauchy be used for more exotic polymers?