Measuring Refractive Index of Microscopy Slides

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Primary CNF Tools Used: Accurion EP3 imaging ellipsometer, Metrican prism coupler

Abstract:

There are plenty of tools that Cornell NanoScale Facilities (CNF) possesses on materials characterization, which is of vital importance to research. In this project, when we measure the refractive index of the microscopy slides (suspected materials), the CNF refractometer, ellipsometer and Metrican prism coupler were considered to be useful. Finally, Metrican prism coupler was used to measure the refractive index of the material, and the refractive index was obtained under a series of wavelengths. We also used the Cauchy model in that it derived to propose the relation of the refractive index of material with the relation of light wavelengths. Through this study, we verified that the materials measured were the exact ones we would like to study.

Summary of Research:

In this research, materials characterization is of vital importance, and the tool set at Cornell NanoScale Facility (CNF) did just the job that what we needed as there are plenty of tools that help researchers with characterization.

Our project is working on the visualization of single polymer growth using single-molecule fluorescence imaging. Total internal reflection fluorescence microscopy is utilized. We're using sapphire and quartz microscopy slides and prisms, the properties of which are of great importance to our experiments. Especially, the refractive index of materials affects the light path in the materials greatly, which should be known clearly in this research.

Different tools (such as refractometer, ellipsometer and Metrican prism coupler) were considered to measure the refractive index of the slide materials. Firstly, Accurion EP3 imaging ellipsometer was applied to measure the refractive index of bulk materials (microscopy slides). After a series of experiments, it was found that it is challenging to get refractive index of slides through ellipsometry. Generally, ellipsometers are able to measure the thickness or refractive index of a thin layer on the known substrate [1]. This thin layer might include metal films, oxides, organic coatings or biological molecule layer such as DNA [2]. For our target materials, slides are the bulk materials.

The Metricon model 2010/M prism coupler utilizes advanced optical waveguiding techniques to rapidly and accurately measure both the thickness and the refractive index/birefringence of dielectric and polymer films as well as refractive index of bulk materials. The 2010/M offers unique advantages over conventional refractometers and instruments based on ellipsometry [3,4]. For example, unlike most conventional refractometers, which are single-wavelength (typically 589 nm), the 2010/M can be equipped with as many as five lasers, allowing easy measurement of dispersion across a wide wavelength range.

The Metrican prism coupler was used to measure the refractive index of the material and the refractive index was obtained. We also used Cauchy model in that it derived to propose the relation of the refractive index of material with the relation of light wavelengths. The refractive index values from the Metricon were obtained and shown as follows:

n@446nm: 1.77734

n@637nm: 1.76311

n@824nm: 1.75705

n@1059nm: 1.75287

n@1058nm: 1.74434

With the refractive index at different wavelengths, the Cauchy model was used to fit the data [5], and the equation between refractive index (n) and light wavelength (.) was obtained and shown as follows.

$$n = 1.7412+1.2954\times10^{4}\lambda^{-2}-1.1617\times10^{9}\lambda^{-4} \quad (1)$$

Figure 1 shows the measured refractive index under different wavelength and the fitting Cauchy equation. The obtained refractive index of our microscopy slide is consistent with the reported refractive index of sapphire materials.

Through this process, we verified that the materials measured were the exact ones we would like to study.

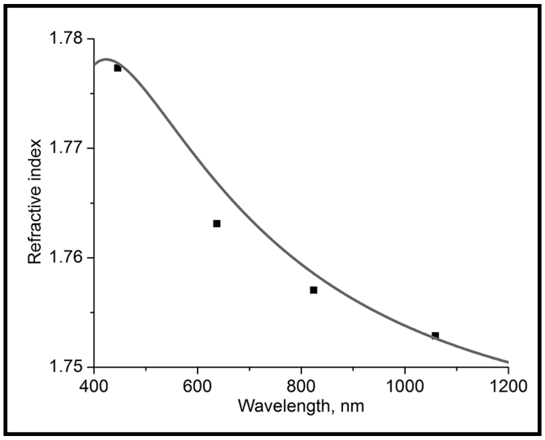

Figure 1: Measured refractive index of the microscopy slide under different wavelength and the corresponding fitting using Cauchy model.

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References:

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