Prospectus

Extreme Ultraviolet Light

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The field of extreme ultraviolet light (XUV) has a great potential to yield information that would be relevant to science and practical applications. Understanding the properties of XUV can have a major impact on photolithography (the process of creating integrated circuit chips). Information on the nature of XUV can aid in the study of the Earth’s magnetosphere. XUV is used in microscopy, which aids in seeing objects undetectable by other means. Due to the way XUV interacts with object, XUV properties are difficult to observe. Extreme ultraviolet light is absorbed by all objects it comes in contact with. Furthermore, extreme ultraviolet light also has low reflectance. These two properties coupled together are problematic as any instruments used in the process of studying XUV have consequences on the integrity of the light ray.

At Brigham Young University (BYU), Dr. Steve Turley’s XUV lab in conjunction with Dr. David Allred thin film lab, a process has been developed to study XUV. Due to the nature of the XUV, it is difficult to observe how it truly interacts with certain substances because it is partially absorbed as well as having low reflection. By using thin film constructive interference with multiple layers of film, it is possible to obtain an unknown index of refraction that corresponds to an isolated wavelength of XUV. If an isolated wavelength strikes the thin film layers at an angle, it is possible to measure the reflected light as a function of angle. The reflectance will also vary due to constructive and destructive interference as the angle changes.

The process takes place in a vacuum chamber where a plasma light source is created in a neighboring chamber. The plasma is used for XUV generation: the generated XUV beam then travels through a diffraction gradient resulting in several wavelengths of XUV. A certain wavelength is isolated from the diffraction gradient and that XUV beam travels on to interact with a thin film. The thin films are either oxidized or have a decaying cap overlaying the material of interest. The angle of incidence can be changed so that way the amount of reflected XUV becomes a function of angle. This is the process in which XUV light can be studied.
What I propose to do is to create modifications to the current system to allow for the use of neon plasma, which in turn should give the lab access to a greater range of wavelengths of XUV to study. This project will contribute to the range of wavelengths that are testable. The neighboring plasma chamber currently uses polycarbonate disk to separate the plasma chamber from the current source. Polycarbonate is problematic due to temperature restrictions and high amounts of current used to create the plasma XUV source can melt the disk. By machining a ceramic disk for the interface in question, neon plasma should then be less problematic. Furthermore, this project will allow for computerized adjustments to wavelengths created by the diffraction gradient. The manual adjusting of the diffraction gradient does not lend itself well to automated measurements. I will assemble a housing that contains a stepper motor that is outfitted with an encoder. This assembly will replace the current device that allows for manual adjustments of the diffraction gradient.

With these two modifications in place I will be able to study the XUV light produced with neon plasma. The thin film that will be used in conjunction with the neon plasma will be yttrium oxide (Y$_2$O$_3$). The first task to be accomplished will be drafting the designs for the ceramic disk and the wavelength adjusting assembly. Following the drafting process, procurement of the necessary materials will be my next undertaking. After acquiring all necessary components, I hope to have all the modifications complete within two and a half weeks. By this point I should be four weeks into this project. After all modifications have been installed, I will begin the attempt to study the varying wavelengths of XUV produced by the neon plasma. The last five weeks of this project will be dedicated to data analysis. The results should yield a relationship of reflectance as a function incident angle. From the data collected, I will determine the index of refraction of yttrium oxide of the different isolated wavelengths of XUV.