Design of a Simple and Robust Asymmetric Ellipsometer for Terahertz

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Abstract

THz spectrum broadly falls in the far infrared in the EM spectrum which lies in between the microwave and optical regime. 0.1THz to 10 THz (1THz=10^12 Hz) is popularly known as THz regime. Unlike the other spectral bands in the EM waves, THz is least explored till now. But lately with the advancement in the research of THz sources and detectors, the research community is gaining interest in exploring different research aspect within THz regime. Also due to the non-ionizing and greater penetration qualities of THz radiation, it makes THz a suitable candidate to replace existing imaging technologies. Apart from this, many other exciting application like spectroscopy of chemical and biological samples, sensing and short range ultrafast communication are being explored.

Ellipsometric study has been the most efficient and accurate method for determining optical constants of a given material over a long time for optical wavelengths. In this article we present a novel concept for designing an ellipsometer for Terahertz (THz) frequencies based on reflection geometry THz Time Domain Spectroscopy (TDS). The present ellipsometers for THz are either based on parabolic mirrors cavities or lens based cavities. The former one has a problem of critical alignment of the optics to achieve variable angular incidence and the later one, though free of aforementioned issue, is having inherent issue of aberration. To solve the aforesaid shortcomings of the two existing type of set ups we propose a set of two asymmetric ellipsoids with a common focus. The combination of two identical ellipsoid with a common focus can support a maximum scan angle of 45º (theoretically). With introduction of asymmetry we have achieved maximum angular variation of incident wave up to ~65º. At the same time entire cavity becoming a single unit, it becomes extremely robust. The fact that source, detector and sample are in co-linear arrangement, alignment becomes trivial. Finally to achieve scanning of incident angle we have to rotate only the substrate, unlike the previous works where synchronous rotation of more than two element was necessary.

Use of COMSOL Multiphysics: With Ray Optics Module the design has become easy, convenient for angular variation without unnecessarily using huge computation resources and time.

Reference

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Figures used in the abstract

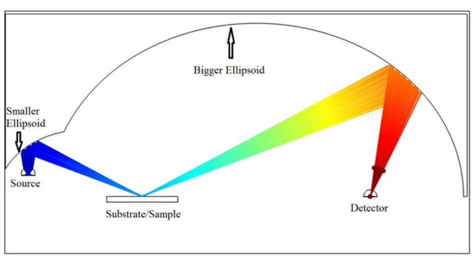

Figure 1: Ray diagram when the substrate is placed at 0º position

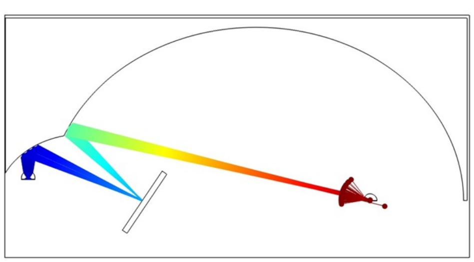

Figure 2: Ray diagram when the substrate is placed at -56º position

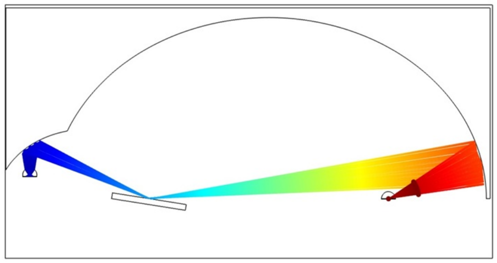

Figure 3: Ray diagram when the substrate is placed at -9º positio