Spectroscopic Ellipsometry Focus Topic
Room Central Hall - Session EL-TuP

Spectroscopic Ellipsometry Poster Session

EL-TuP-1 Ultra High-speed Spectroscopic Ellipsometry and its Applications, ***Gai Chin,*** ULVAC, Japan

As a comprehensive manufacturer of metrology tools and deposition tools, ULVAC developed an innovative ultra high-speed spectroscopic ellipsometer for many deposition applications, such as PVD, CVD, ALD and others.

This novel spectroscopic ellipsometry can measure the thickness and optical constants of thin films at a dramatically fast speed. Its data acquisition time is as short as 10 ms. It does not require any active components for polarization-control, such as a rotating compensator or an electro-optical modulator.

It created great opportunities for new applications of the spectroscopic ellipsometry in which the compactness, the simplicity and the rapid response are extremely important. It can be integrated into the deposition tool and successfully measured thin films in-situ and ex-situ. Obviously, PVD, CVD and ALD are some promising applications for this novel spectroscopic ellipsometry.

This paper describes the principle, system configuration and our creative efforts on developing a series of ultra high-speed spectroscopic ellipsometers. Some of the novel applications will be also introduced, such as the PVD, CVD, ALD, EUV, OLED, MEMS and some measurement data of thin films from the semiconductor, flat panel display and other industries.

EL-TuP-2 Comparing and Evaluating the Calculation Results of Measurement Uncertainty for Various Types of Rotating-element Spectroscopic Ellipsometers, ***YongJai Cho,*** *W Chegal, H Cho,* Korea Research Institute of Standards and Science, Republic of Korea

Various multi-channel rotating-element spectroscopic ellipsometers have excellent measurement abilities like real-time, high-precision, non-destructive, and contactless schemes, and as a result have been widely used in a semiconductor manufacturing process. With the development of semiconductor device process technologies, the thickness of the thin film used for these technologies is getting smaller and smaller and thus reaches a level of atomic layer and the shape of the nano pattern is changed from a two-dimensional structure into a three-dimensional structure and thus is becoming increasingly complicated. Therefore, for the rotating-element spectroscopic ellipsometers to be continuously used as a measurement tool for next-generation semiconductor industries, it is important to continuously enhance their measurement uncertainties. Recently, we developed the universal evaluations and expressions of measuring uncertainty for all types of rotating-element spectroscopic ellipsometers. We also introduced a general data-reduction process to represent the universal analytic functions of the combined standard uncertainties of the ellipsometric sample parameters. To solve the incompleteness of the analytic expressions, we formulated the estimated covariance for the Fourier coefficient means extracted from the radiant flux waveform using a new Fourier analysis. Our approach can be used for providing a method for calculating a theoretical model equation which may be applied to various kinds of multi-channel rotating-element spectroscopic ellipsometers and may determine a measurement confidence level thereof, that is, a theoretical equation on standard uncertainties of ellipsometric parameters determined on the basis of a series of observations for a sample. In this presentation, it will show that the calculation data of the combined standard uncertainty for the various types of the rotating-element spectroscopic ellipsometers are obtained using the universal expressions for the combined standard uncertainty. In particular, the calculation results for the dual-rotating-compensator spectroscopic ellipsometers will be compared and evaluated with the calculation results for the common single-rotating-element spectroscopic ellipsometers.

EL-TuP-3 Ellipsometry Analysis of a Germanium-on-insulator Wafer, ***Rigo Carrasco,*** *N Samarasingha Archichchege,* New Mexico State University*; B Nguyen,* Soitec, France*; S Zollner,* New Mexico State University

Germanium based photonic devices attract a lot of interest due to the fact that its band structure is easily influenced by strain and alloying with tin. A direct bandgap group IV semiconductor will show an improvement in efficiency in optoelectronic devices. Utilizing a germanium-on-insulator (GOI) substrate is a key feature for future silicon compatible germanium based devices, allowing for easier integration by the microelectronics industry. [1]

Here, we analyzed the optical response of a GOI bonded wafer via spectroscopic ellipsometry. The ellipsometric angles, psi and Delta, and the depolarization were acquired from 0.5 to 6 eV in 0.01 eV increments using a J.A. Woollam variable angle spectroscopic ellipsometer (VASE) and from 0.1 to 0.8 eV using a Fourier transform infrared (FTIR) ellipsometer, allowing high precision measurements in the mid-infrared range. The measurements in both ranges were performed at angles of incidence from 60 to 75 degrees in 5 degree increments.

The optical response of the GOI wafer was modeled with four layers (Si, buried oxide, Ge, native oxide). As expected, strong interference oscillations were observed below the E1 critcal point of Ge. For Ge, we used the parametric semiconductor oscillator model and compared it to our previously determined optical constants of bulk germanium. We are particularly interested in differences near the direct band gap. The infrared phonon vibrations of the buried oxide were also visible in the measurements. The same measurement procedure was performed on the GOI wafer before and after cleaning the sample to observe the optical effects of a native surface oxide. While the pseudo-dielectric function of the GOI sample appeared different from that of a bulk Ge sample due to interference effects, the optical constants of the germanium layer only showed small differences. We did not find any differences in the electronic structure of bulk Ge and a thin bonded Ge layer.

References:

[1] B.Y. Nguyen, M. Sadaka, G. Gaudin, W. Schwarzenbach, K. Boudele, C. Figuet, C. Maleville

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