Comprehensive Optical and Compositional Characterization of Silicon-based Thin Films for Photonics - J. Wojcik, E.A. Irving, J.A. Davies (McMaster University), W.N. Lennard (The University of Western Ontario), and P. Mascher (McMaster University)

Silicon-based thin films, with compositions ranging from amorphous silicon (*a*-Si) to silicon-oxynitrides (SiO_xN_y) and to silicon-rich silicon-oxides (SRSO) are finding widespread applications in today's microelectronics and photonics industries. Among the most important applications pursued in our laboratories are their uses as anti-reflection and highly reflective optical coatings, as facet coatings in the development of compact diode laser sources for the generation of ultra-short light pulses, as critical components for band gap shifting in 1.55 μm quantum well laser structures, and more recently, in the fabrication of Erbium doped waveguide amplifiers, using an Er chelate as the dopant source and SiO_xN_y or SRSO films as the host glass.

In this talk, we will discuss a number of characterization issues relevant to the fabrication of the films that meet the stringent requirements of the above applications. We will discuss the respective strengths of several complementary characterization techniques used in our research program. These include spectroscopic and conventional, single-wavelength ellipsometry, a powerful method to determine the optical characteristics and film thickness. Among the ion beam analytical techniques, nuclear reaction analysis (NRA) is used to accurately quantify simultaneously the oxygen and nitrogen areal densities, elastic recoil detection (ERD) to determine the hydrogen concentration in the films, and Rutherford backscattering (RBS) to quantify dopant concentrations. Fourier transform infrared (FTIR) and X-ray photoelectron spectroscopies (XPS) provide information about the inter-atomic bonding characteristics.

In addition to highlighting the respective strengths of the individual characterization techniques, we will emphasize the importance of combining several of the described techniques to gain a comprehensive understanding of the intricate relationship between the optical and compositional characteristics of the thin films. Finally, we will briefly address the issue of thin film – substrate interactions and point towards characterization tools useful in this context.

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