Optical measurements laboratory

The laboratory performs investigations rely on the methods of spectroscopic ellipsometry, interferometry, reflectometry and Raman spectroscopy. These methods are used, among others, to determine the thickness and optical characteristics of various layered structures, the distribution of mechanical stress and chemical content in various objects.

With spectroscopic ellipsometry the spectral characteristics of ellipsometric angles $\Psi(\lambda)$ and $\Delta(\lambda)$ are measured in order to evaluate e.g. layer thickness (mostly dielectric), spectral characteristics of complex refractive index $N(\lambda)$ and complex dielectric function $\varepsilon(\lambda)$ (where $N = n + ik$ and $\varepsilon = \varepsilon_1 + i\varepsilon_2$). Spectroscopic ellipsometry is also a valuable tool for determination of band gaps of high-k dielectrics and semiconductors. Two spectroscopic ellipsometers are used: the first, Variable Angle Spectroscopic Ellipsometer of J.A. Woollam Company Inc. using the light wavelengths $\lambda = 250 \div 1700$ nm and working at angles in the range from 15 to 84 degrees (Fig. 6a) and the second, Scanning Spectroscopic Phase Modulated Ellipsometer (UVISEL VUV) ellipsometer of HORIBA JOBIN YVON S.A.S using the light wavelengths $\lambda = 142 \div 880$ nm and operating at 70 degree angle (Fig. 6b).

Spectrophotometry allows for measurements of spectroscopic transmission and reflection in ultraviolet, visible light and near-infrared (UV-VIS-NIR) in both solids and liquid solutions. Two beam spectrophotometer Shimadzu 3600 (Fig. 6c) operating in ranges of UV, VIS and IR wavelengths allowing measures transmission and reflection spectra for both liquids and solids. Working range of $\lambda = 185 \div 3300$ nm with at least three detectors: photomultiplier, InGaAs, PbS.

Raman spectroscopy consists in analysis of Raman spectrum shift, which enables evaluation of mechanical stress distributions in investigated samples, and identification of some chemical particles which may be present in the structure (e.g. carbonic clusters in SiC-SiO_2 interface). The Raman system (Fig. 6d) is equipped with MonoVista Micro-Raman Spectrometer (Spectroscopy and Imaging GmbH Germany) with JAI imaging camera and CCD detection camera, argon laser with wavelength 488nm, Nd-Yag (CryLas GmbH, Germany) and with wavelength 266 nm.

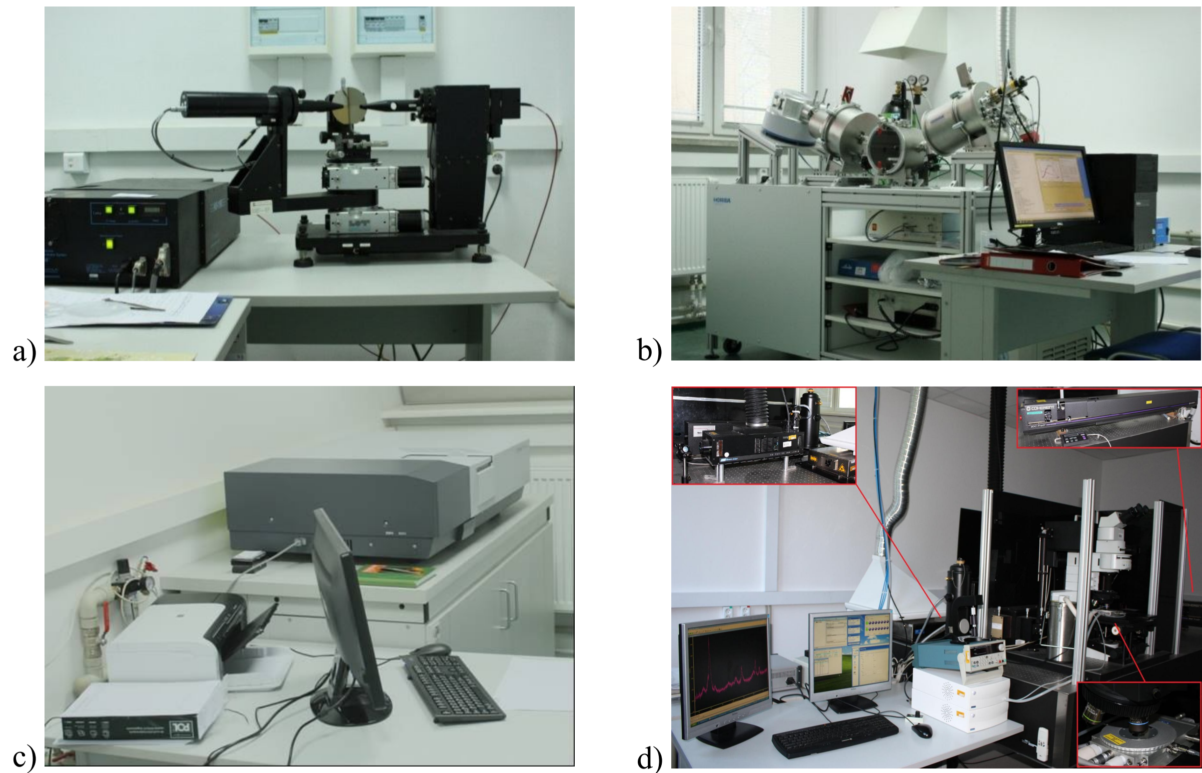

Fig. 6 Measurement systems dedicated for optical investigations: **a)** Variable Angle Spectroscopic Ellipsometer of J.A. Woollam Company Inc., **b)** Scanning Spectroscopic Phase Modulated Ellipsometer (UVISEL VUV), **c)** Two beam spectrophotometer Shimadzu 3600, **d)** MonoVista Micro-Raman spectrometer.