To whom it may concern

« Light Polarization in infrared and terahertz spectral range »
by Tomáš Horák, B.Sc.

This master thesis describes the research activities of Mr. Horák on the calibration and optimization of a spectroscopic ellipsometric setup under extension towards far- and mid-infrared frequencies. Secondly, first experimental investigations into terahertz time-domain spectroscopy are also presented. In view of the strongly increasing global research interest that these spectral ranges are presently receiving, the mastery and good understanding of the characterization techniques at these non-traditional wavelengths is very important. The subject of this master thesis assignment is therefore a very relevant and timely choice.

The extension of traditional visible and near-infrared spectroscopic techniques such as polarimetry, ellipsometry and photospectroscopy towards longer wavelengths has to be done with care. Specifically, a pronounced spectral polarization dependence and non-ideal behavior of the different optical elements in these instruments can undermine a correct interpretation of the measurement data.

Mr. Horák has shown through this thesis report a very good understanding of the subject matter and challenges related to it. He clearly situates and compares the existing techniques. He recalls the theoretical foundations of the Mueller-Stokes approach for the analysis of partially polarized signals. Subsequently he uses this theory to propose several models to take imperfections in polarization components (or polarization dependence of the detectors) into account. These models are rigorously validated by experimental characterization and numerical fitting procedures. In this way, Mr. Horák has demonstrated a reliable calibration technique of a FTIR-based ellipsometer over a wide spectral infrared range. Most importantly, he has very convincingly validated this calibration by using it to reproduce the ellipsometric angles of a known gold sample over a wide infrared spectral range.

Cité Scientifique, Avenue Poincaré - CS 60069
59652 Villeneuve d'Ascq Cedex
At all times, Mr. Horák demonstrates strong skills as a (future) engineer by simultaneously mastering advanced instrumentation techniques and adapting their theoretical models to realistic and practical situations. Throughout, this master thesis demonstrates his attention to scientific rigor and his focus on the essence of the matter. If only a very small criticism can be formulated, then it must be that, at times, his description is too succinct and concise leaving the text somewhat difficult to follow for a non-initiated readership. Overall however I believe this work to be of excellent quality for a master degree level, and recommend it to be awarded an excellent score (Score 1).

\[Signature\]

dr. ir. Mathias Vanwolleghem

CNRS senior researcher
Institut d'Electronique, de Microelectronique et de Nanotechnologie
Villeneuve d'Ascq
France

Herewith I join a list of possible questions for Mr. Horák concerning some topics treated in the thesis. I leave it up to to discretion of the jury and its president to choose any (or none) to be considered by the candidate at his thesis' defense.

- it is not entirely clear from the text what is the meaning of the coefficients T1 and T2 in the calibration of the ellipsometer. Is it a correction coefficient to take into account a non-ideal detection efficiency of the harmonic intensities?

- with attenuation coefficients close to 1 (for the source and the detector) what is the meaning of the angle? Does it make any sense to use an angle if the components are almost perfectly polarization transparent? Does it have a lot of influence on the fitting?

- Similarly, with fitted attenuation coefficients for the source so close to 1 (ie almost perfect polarization transparent) does it make any sense to include this virtual polarizer for the source. Can't acceptable fitting still be realized without a correction for the source?

- Does the candidate have an idea about the error bars on the fitted ellipsometric angles of Fig. 49 and 50

- Very little details are given on the TDS measurements. Can the candidate provide more information on this system. Is it home-built or commercial? Are the samples always characterized in reflection? Is the polarization of the THz beam controlled? ]