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Biomolecular Layers on Silicon Studied by Optical Spectroscopy

Dietrich R. T. Zahn[1] and Simona D. Silaghi[1]

(1) TU Chemnitz, 09107 Chemnitz, Germany

Abstract
Amongst biomolecules the DNA base molecules adenine, cytosine, guanine, and thymine may also find interesting applications in organic electronics. They have optical gaps in the near ultra-violet and have already been considered as charge transport molecules in organic field effect transistors. Still there is very little knowledge on their electronic and optical properties when deposited as layers on inorganic substrates. Here the optical properties of the DNA bases deposited on flat and vicinal, hydrogen passivated Si(111) substrates are studied using spectroscopic ellipsometry (SE) up to 9.5 eV photon energy employing synchrotron radiation and reflectance anisotropy spectroscopy (RAS). The results for the dielectric function reveal strong optical anisotropy for adenine and guanine while the other two molecules form layers with isotropic properties. The experimentally derived dielectric functions are compared to density functional theory calculations of the optical response. Particularly interesting is the RAS response of the DNA bases as a function of thickness when deposited on vicinal Si surfaces. Ordering in the layers is induced by the step and terrace structure of the vicinal Si substrates. Even though the molecular structure is not dramatically different the RAS response is very distinct and allows an unambiguous identification of the bases.

Dietrich R. T. Zahn
Email: zahn@physik.tu-chemnitz.de