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In situ reflectance anisotropy spectroscopy monitoring of wide bandgap biomolecules on vicinal silicon surfaces

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Abstract
DNA base molecules, adenine, thymine, guanine, and cytosine may be employed as charge transport molecules in biomolecular electronic devices. Their electronic properties compete with those of inorganic wide bandgap materials, *e.g.* GaN, with the absorption onset in the near ultra-violet (UV) range. A recent field effect transistor study based on a modified DNA base revealed that the prototype bio-transistor gives rise to a better voltage gain compared to a carbon nanotube one (CNT) [1]. Reflectance Anisotropy Spectroscopy (RDS/RAS) measures the difference in reflection for normally incident light linearly polarized along two orthogonal directions in the sample surface as a function of photon energy. *In situ* RDS/RAS is employed under ultra-high vacuum (UHV) conditions for the first time for the characterization of DNA base molecules on vicinal hydrogen passivated Si(111) surfaces. Such vicinal substrates consisting of steps and terraces can provide a versatile template for molecular ordering. Indeed, the RDS/RAS measurements reveal information about molecular ordering of DNA bases induced by the density of steps on silicon surfaces. All four molecules behave differently on the vicinal substrates. The orientation of the transition dipole moments of the molecules with respect to the substrate directions can be evaluated from the RDS/RAS spectra. For adenine and thymine the transition dipole moments align mainly perpendicular to the step edge direction while for guanine and cytosine they align parallel to this direction, however, only in very thin layers. The RDS/RAS signal of the guanine and cytosine layers with thicknesses above 20 nm saturates due to the loss of ordering.

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