Chemical Bonding States at Silicon / Silicon Dioxide Interfaces Characterisable with Light

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The importance of characterising the atomic structure of the silicon / silicon dioxide interface as an essential component in highly integrated circuits has steadily increased as a result of continuing miniaturisation of silicon chips. The physicists, Dr. Stefan Bergfeld, Bjoern Braunschweig and Prof. Dr. Winfried Daum, Institute of Physics and Physical Technologies at the Technical University of Clausthal, **have succeeded in characterising the change in bond structure of interfacial atoms during the oxidation of a silicon surface by a purely optical method**. The results of the research have been published in the scientific journal, Physical Review Letters, Volume 93, No. 9 (online on 27th August 2004).

In the present work, the atmospheric oxidation of a hydrogen-covered (111)-oriented silicon surface has been studied, and special bonding states of the silicon atoms have been identified. The scientists also observed these bonding states after the technically relevant thermal oxidation. For characterising the interfaces, the physicists apply a special nonlinear-optical method, with which the laser light is converted by interfacial atoms to photons with energies in the near ultraviolet range by doubling of the frequency. This purely optical spectroscopic method with frequency doubling allows nondestructive characterisation of the oxidation process under real conditions and also provides very high interfacial sensitivity, in comparison with other optical methods.

The Si(111)-SiO2 interface is a prime example of an abrupt transition from a perfect crystal structure to an amorphous oxide. In contrast to the technologically more relevant Si(100) surface, the surface of a (111)-terminated silicon crystal possesses a structure consisting of bi-layers, in which changes in the bond structure resulting from oxidation can be observed especially well.

Source: Technical University Clausthal