TASC National Laboratory
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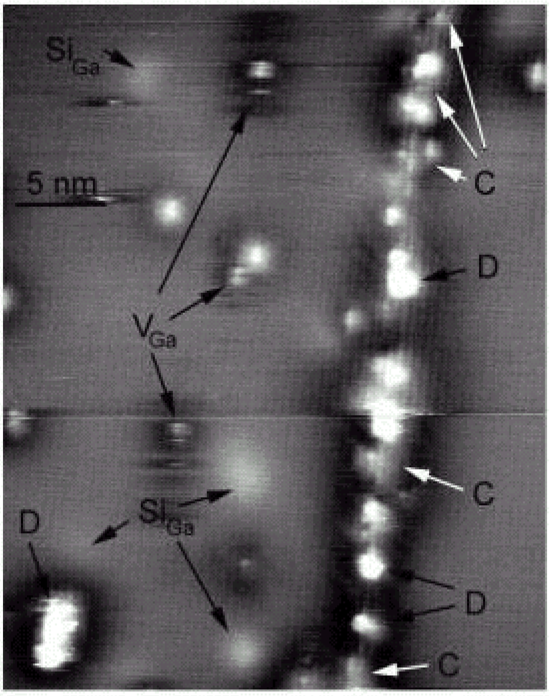
XSTM and low-temperature STM of nanostructures

The main activities of the laboratory are:

1) the cross-sectional scanning tunneling microscopy (XSTM) and spectroscopy (XSTS) of nanostructures in III-V semiconductors.
2) the scanning tunneling microscopy (STM) and spectroscopy (STS) of nanostructures based on carbon nanotubes and of low temperature phases of metallic surfaces on semiconductors.

Cross-sectional scanning tunneling microscopy can allow studies of the local morphology, composition and electronic structure of semiconductor nanostructures with unparalleled spatial resolution. Epitaxial semiconductor structures grown by molecular beam epitaxy (MBE), such as delta-doped layers, quantum wells, superlattices, quantum dots, are cleaved in-situ in a ultra-high-vacuum compatible, variable-temperature scanning tunneling microscope. The resulting {110} cross sections of the nanostructures of interest are examined in both XSTM and XSTS modes. Imaging of impurity and defect states, local injection into quantum-confined states, and quantitative analysis of the potential profile across functional devices are only some of the results achievable by the XSTM/XSTS combination. The focus of our investigations is on three challenging aspects of current nanostructure physics: a) Impurities, defects and self-compensation; b) Local alloy fluctuations; c) Localization and correlation effects in quantum-confined structures.



Cross-sectional STM image of 2 ML of Si in GaAs. C indicates Si rich clusters, Si_{Ga} isolated Si donors, V_{Ga} surface Ga vavancies, D cleavage defects

The researches are done in collaboration mainly with the Material Division and the Electron Microscopy Laboratory of TASC, and with the DEMOCRITOS Research and Development Center.

Carbon nanotubes (CNT) have been proposed for many applications, but an important obstacle for the development of nanotube-based technologies is the fact that they are insoluble in any solvent ant that

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they are often produced in a spaghetti-like structure.

The organic functionalization of CNT's may solve these problems allowing their purification and the use of the nanotubes as a normal building block.

The Prato group at the Trieste University has devised a general method of fullerene functionalization, based on the 1,3-dipolar cycloaddition of azomethine ylides to C60 and nanotubes. The cycloaddition reaction allow the insertion of any functional group in the system. The study of the structure and of the properties of the functionalized nanotubes by STM is now being performed at TASC-INFM.

Quasi two-dimensional metals on semiconductor surfaces show interesting phase transitions and electron correlation effects. Our laboratory is studying metallic layers formed by 1/3 of a monolayer of tetravalent adatoms on the (111) surfaces of Si and Ge in order to understand the nature of the phases observed in this systems.

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