## Abstract of thesis

Semiconductor materials play a crucial role in modern society as they have become integral parts of our daily life through personal computers, mobile phones, medical implants, solar panels and a plethora of other commercially available electronic devices. The semiconductor industry has been relying predominantly on silicon so far and will continue to do so for a few more years, until the material limits for miniaturization and device engineering are reached. Fortunately, worldwide research has already demonstrated that there are materials exhibiting superior mechanical, electronic, and optical properties and which can thus replace or at least complement silicon. This represents a very important step towards satisfying the ever rising global demand for smaller, faster, energy-efficient and cheaper electronic devices. To that end, nowadays research is focused on fabrication and characterization of diverse materials and nanostructures which are aimed to be integral in electronic devices. Due to the miniaturization, it is essential that the electronic, structural and chemical characterization and modification of those novel materials and structures is performed on the microscopic scale. The relatively young but nevertheless rapidly expanding and exciting field of nanoscience and nanotechnology has provided scientists with a wide range of appropriate instruments over the past few decades which are able to fulfil this need. In this work, we examine and modify in the nanoscale two application-relevant systems: 1) nanocrystalline diamond thin films and 2) hydrogenated amorphous silicon thin films.

We study nanocrystalline diamond as a relatively novel semiconducting material due to its unique combination of electronic, mechanical, thermal and optical properties. As recent developments have allowed the production of electronic grade synthetic diamond, prospects have opened for its utilization in real applications. We tailor the diamond deposition for production of thin films with the desired thickness, material purity and nanocrystal size. Characterization of the structural, chemical and electronic properties is performed mainly by scanning electron microscopy, micro-Raman spectroscopy and various scanning probe microscopy (SPM) techniques. The latter are also utilized for surface modification of the diamond. By that we resolve that the grain boundaries are predominantly responsible for 1) electronic transport and 2) electrostatic charging of oxidized diamond when the film is subjected to an external electric field. In addition, we demonstrate that it is possible to self-assemble nanoparticles on such charged diamond surfaces if the stored charge in the diamond is enough to create potential contrast (and related electrostatic field) of at least ±1 V. We

identify and explore the parameters that lead to effective electrostatic charging of diamond by close correlation of material properties ($sp^2/sp^3$ ratio) and experimental parameters (voltage, current, applied force, and material of SPM probes). These results have the potential to be utilized for self-assembly of hybrid nanodevices. Such devices can at the same time benefit from the unique properties of diamond.

The second system that was studied in this work is hydrogenated amorphous silicon. We apply atomic force microscopy to promote phase transition from amorphous to crystalline silicon and thus define micro- or nano-scopic crystalline features in the amorphous material. Development of such technology can be beneficial for fabrication of electronic or optical nanodevices that require precise positioning of nanocrystals. Such devices can also benefit from the usage of amorphous silicon substrate due to its easy and inexpensive fabrication when compared to silicon wafers. As another route we also demonstrate selective deposition of silicon nanocrystalites in pits of nanoscale dimensions which are created in the amorphous film by SPM.

We conclude this thesis with a chapter proposing combination of the two materials above. To that end we use the pits in the amorphous silicon films as templates for diamond deposition and we investigate the influence of the deposition parameters. We evidence selective growth of diamond nanocrystals with pronounced graphitic content within the pits. The progress reported here provides an important piece of knowledge for future research and applications of diamond and silicon nanostructures.