# Abstract

This thesis is based on the nanostructure research accomplished within the Scanning Probe Group (head: Prof. Dr. R. Wiesendanger) of the Microstructure Research Center at the Institute for Applied Physics of Hamburg University. The work was done in close cooperation with the Analytical Research Group of the Beiersdorf AG, Hamburg, within the framework of a BMBF (Federal Ministry for Education and Research) project. The overall aim of this Ph.D. study was the development of an improved low-temperature scanning force microscope (SFM) to visualize and characterize biological and organic systems down to the molecular scale. In addition to the conceptive and constructional work the capabilities of the new SFM-device were proven by application to selcted model structures.

The plan of the thesis is as follows: Chapter 1 treats the fundamentals of the SFM technology with special regard to biological systems. It is elucidated, that a subtle combination of SFM and cryo techniques offers a variety of unique research possibilities in the fields of structural biology.

Chapter 2 describes the complete measuring equipment consisting of an ultra-high vacuum (UHV) system, the load lock, the preparation chamber and the analysis chamber. The load lock not only governs the simple tip-sample transfer, but also offers compatibility with cryo-scanning-electron (SEM) and cryo-transmission-electron (TEM) instrumentations so that properly cooled samples may be interchanged. The preparation chamber provides options for sample preparation by in situ freeze-fracturing and freeze-etching. In the analysis chamber a flow-cryostat cools down the sample to the temperature of liquid nitrogen (77 K), the tip is scanned with a maximum range of 100 $\mu$m $\times$ 100 $\mu$m.

In chapter 3 the cryo-preparation of the samples is addressed. Owing to the high water content, biological samples must be frozen very carefully in order to avoid any destructive segregation effects due to ice crystallization. The applied methods are discussed with special emphasis on the inherent advantages and disadvantages.

In chapter 4 the usefulness of the developed cryo SFM-device is demonstrated with the aid of test systems (graphite and gold) and a biological model system, T4-viruses. The results originate from low temperature measurements obtained by contact and noncontact scanning modes.