CHAPTER 1
INTRODUCTION

Microelectromechanical Systems (MEMS) (1-2) is the most recent field, which has come into existence only in the last decade and has promised to deliver miniaturized products into every field of science. One of the major impacts of MEMS technology would be in the field of clinical disease diagnosis. Several research groups in different parts of the world are involved in using this technology for the development of miniaturized diagnostic kits, which would revolutionize the field of healthcare. Scientists are chasing the vision of making miniaturized biochip which can detect several routinely diagnosed diseases in the clinical laboratory in one parallel go. The innovative technology would bring relief to the patient community as several diseases could be diagnosed just by using a microlitre of the patient’s blood sample.

The microcantilevers are the most simplified MEMS based devices, which have been used by researchers in different fields. Diverse applications of microcantilevers in the field of sensors have been explored by researchers but the most prominent one i.e. in the field of clinical diagnosis has not yet been fully explored. Various groups are working in different parts of the world to diagnose clinical diseases employing microcantilevers. Several groups have shown the possibility of using microcantilevers for the diagnosis of clinical diseases such as prostate cancer (3), myocardial infarction (4) and glucose monitoring (5).

The work stated in this thesis is a step forward in the direction of solving some of the critical problems which are posing a hurdle in the way of commercialization of microcantilever based diagnostics. Thinking in the direction of commercialisation, various parameters i.e. biological, biomechanical and design aspects of the microcantilever based diagnostic device have been studied in depth.

The biomechanical parameters were assessed by simulation. Various parameters were calculated theoretically by taking into consideration the mass and size of biomolecules, the spatial coverage of biomolecules on the cantilever and the force these biomolecules exert on the microcantilever. The biological parameters of the microcantilever based diagnostic kit were determined by employing various
immobilization strategies for binding biomolecules i.e. antibodies on the active functionalized surface of the silicon microcantilever. The immobilization strategies involved the use of protein A, protein G, biotin-avidin interactions, 3-aminopropyltriethoxysilane (APTES), glutaraldehyde and $N$-ethyl-$N'$-(3-diethylaminopropyl) carbodiimide (EDC). The immobilization levels of biomolecules on the cantilever surface were determined by inverted fluorescence microscopy and by employing horse radish peroxidase labelled biomolecules and fluorescence spectroscopy. The uniformness of biomolecular coverage and size of the immobilized biomolecules were analyzed by atomic force microscopy (AFM).

Immobilization of biomolecules was done on a variety of solid substrates i.e. silicon chips, gold coated silicon chips and polylysine coated glass chips. The next generation of MEMS based devices may employ any of these solid supports.

While working on the polylysine coated glass slides, a new phenomenon of change in electrical conductivity of biomolecules immobilized on the surface was observed which could be of relevance to the field of biosensors and would be of immense use in understanding the molecular electronics of the solid surface immobilized biomolecules. Various parameters pertaining to this concept like the current-voltage, temperature, and stability were also analyzed. The work described in this thesis is a positive step in unveiling the complex mechanisms taking place at the nanobiomolecular level.