

QUANTUM DOT–BASED BIOSENSORS FOR CANCER DETECTION

ADITYA SHARMA



DEPARTMENT OF CHEMISTRY

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QUANTUM DOT–BASED BIOSENSORS FOR CANCER DETECTION

by

ADITYA SHARMA

Department of Chemistry

Submitted

in fulfillment of the requirements of the degree of

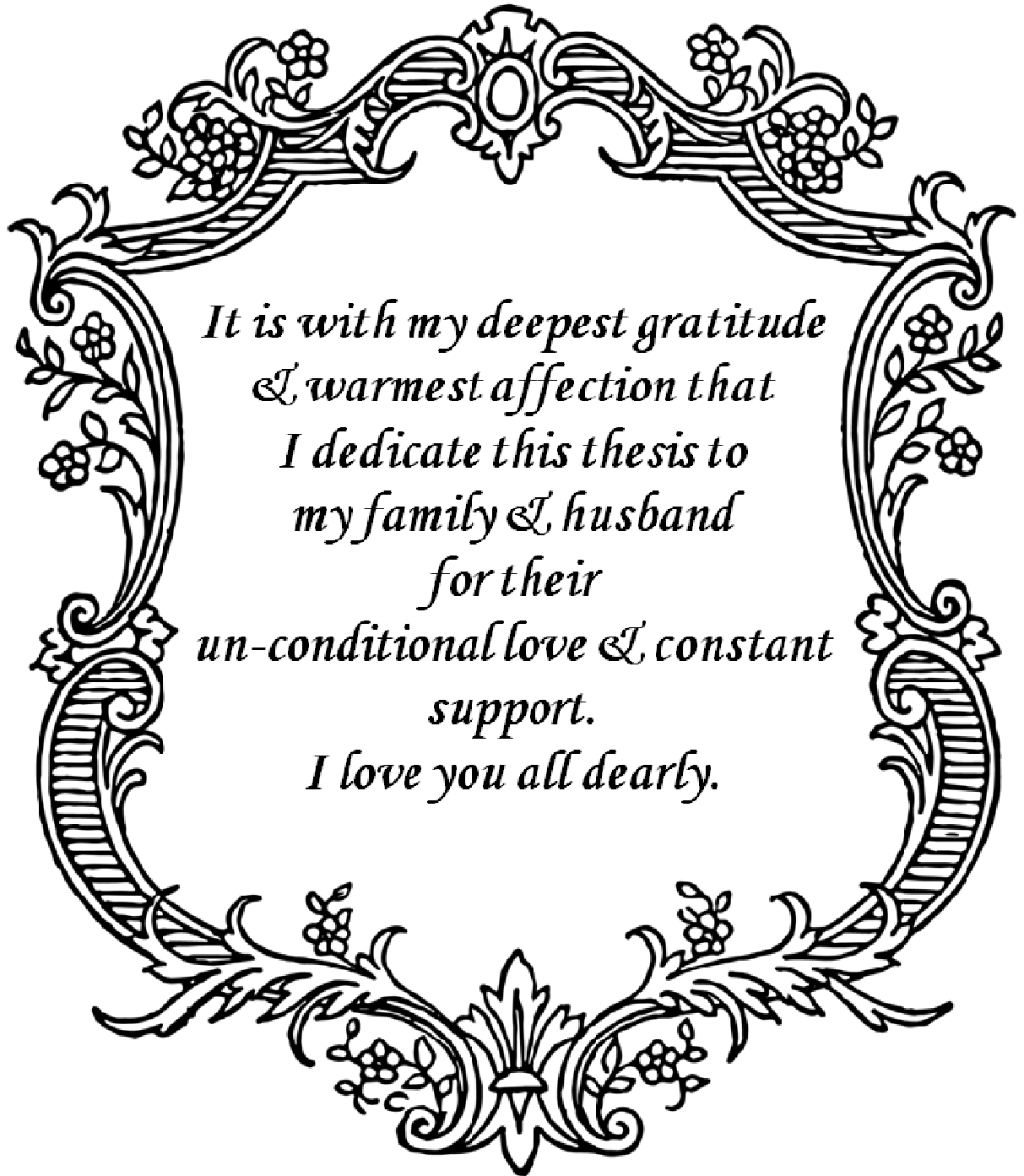
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*It is with my deepest gratitude
& warmest affection that
I dedicate this thesis to
my family & husband
for their
un-conditional love & constant
support.
I love you all dearly.*

CERTIFICATE

This is to certify that the thesis entitled, “**Quantum Dots Based Biosensors for Cancer Detection**”, being submitted by **Ms. Aditya Sharma** to the Indian Institute of Technology Delhi for the award of the degree of Doctor of Philosophy in Chemistry, is a record of the bonafide research work carried out by her. Aditya has worked under our guidance and supervision. She has fulfilled the requirement for the submission of this thesis, which to our knowledge has reached the requisite standard.

Dr. Sameer Sapra
(Supervisor)
Department of Chemistry
Indian Institute of Technology Delhi
Delhi-110016

Dr. B. D. Malhotra
(Co-Supervisor)
Department of Biotechnology
Delhi Technological University
Delhi-110042
Ex. Chief Scientist
CSIR-National Physical
Laboratory

Dr. Gajjala Sumana
(Co-Supervisor)
CSIR-National Physical
Laboratory
Delhi-110012

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ABSTRACT

Chronic myelogenous leukemia (CML) is a haematological disorder that caused by a single, specific genetic mutation. More than 90% of cases result from a cytogenetic aberration known as the Philadelphia chromosome arising from t(9;22)(q34;q11) reciprocal translocation. Current clinical diagnostic techniques of CML are laboratory based, labor-intensive, expensive and time-consuming, which limit their application as routine diagnostic tool that may result in the delay of the prognosis and decision-making for treatments. Therefore, we have focused efforts on the development of a biosensor having high diagnostic specificity and sensitivity to make possible the point of care analysis and diagnosis of CML at an early stage.

This thesis deals with the preparation, characterization and application of QD-based thin films for detection of CML using electrochemical and optical transducer systems.

The **Chapter 1** of the thesis is devoted to an extensive literature survey on research work in the area of CML detection. It presents an overview of the various techniques available for CML detection and the prospects of biosensor for this current application. A detailed review of the literature regarding biosensor applications for CML detection is presented. Further, the prospects of quantum dots towards biosensor fabrication are also discussed.

Chapter 2 presents a brief overview of CML specific DNA sequences used for the biosensing studies and the processing of the clinical patient samples. It also deals with the techniques used for characterization of thin QDs films deposited using various methods, and the bioelectrode fabricated via these QD-based films.

In **Chapter 3** studies relating to the fabrication of a sensitive electrochemical biosensor using QDs self-assembly based interface are performed. The larger surface area of three-dimensional structure of QDs as compared to that of the two-dimensional

structure of the self assembled monolayer is found to result in a decreased barrier to the diffusion of redox species, thereby contributing to improved kinetics compared to that observed in the absence of QDs. Further, QDs are encapsulated inside the chitosan polymer matrix to improve the stability of QDs. The nano-composite is electrophoretically deposited on an ITO electrode and examined for fabrication of an electrochemical CML biosensing.

In **Chapter 4** Langmuir monolayer of tri-n-octylphosphine oxide capped CdSe behaviour is studied at the air-water interface under various subphase conditions. Under optimized conditions, when an ordered arrangement of the particulates is obtained, the monolayer is deposited on an ITO substrate using the Langmuir-Blodgett (LB) technique, which is subsequently explored to fabricate an electrochemical DNA biosensor for CML detection.

In **Chapter 5** LB deposition of a QCdSeZnS-SA mixed monolayer has been performed for repetitive cycles to obtain multilayer depositions onto an ITO substrate. Thiol-terminated capture probe is immobilized on the thin film for biosensor fabrication. Hybridization of the capture probe with indodicarbocyanine (Cy5)-labelled target DNA brings the acceptors within the Förster distance of QDs, thereby generating an efficient FRET. The reduction in donor fluorescence lifetime and the enhancement of FRET ratio as a consequence of FRET is measured.

The **Chapter 6** summarizes results presented in the thesis that highlight the role of quantum dots and their arrangement on the substrate for delivering the sensing characteristics of the affinity biosensor. Comparisons of electrochemical and FRET-based biosensors have also been performed using QD films as the immobilization matrix.

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