Preface

The objective of this research work was to develop a process for fabrication of photomasks for Surface Acoustic Wave (SAW) sensor applications. The approach adopted was development of a process for fabricating photomasks using LASER Pattern generator and validating the same by fabricating photomask as per the designed SAW resonator device patterns, which could be subsequently transferred from photomask to the wafer for fabrication of the device to be used as a gas sensor (Sarin-DMMP).

The requisite photomask fabrication process was developed using a variety of test structures designed for this purpose and then validated by fabricating a SAW resonator photomask as per designed specifications, using the developed process. The fabricated photomask was used for fabricating the resonator on a Quartz substrate. The fabricated device was packaged, bonded and finally characterized by measuring its response and performance as SAW Resonator based Gas sensor for Sarin (DMMP). The Resonator fabricated was designed for operation at 500 MHz and having critical dimension of 1.69 μm.

The details of the work carried out are described in five chapters. The description of various chapters is as follows:

Chapter 1 gives an overview of photomask technology (historical perspective). In this chapter, a brief overview of the SAW technology has also been described as the ultimate objective of the work is to develop a comprehensive process for fabrication of the extremely low design tolerance photomasks required for fabrication of SAW devices.

Chapter 2 describes details of the designed test structures used for photomask process development. Various Data Formats used for preparation of the test designs, conversion of the test data to a data format required for pattern writing on the chrome blanks using the LASER Pattern Generator have been described. In addition, concepts of data slicing, grid snipping, scan field stitching, LASER proximity effects and loading effects have also been described.

Chapter 3 covers the mask pattern writing. The three basic pattern generation techniques-raster scanning, vector scanning and variable shape beam concepts have been described to understand the writing process. Components of a LASER pattern generator are described along with currently available LASER pattern generators in the market. The Chrome blanks used for the research along with photoresist are explained. The exposure optimization using LASER Pattern generator (DWL 200) for Bright field and Dark field masks is described.

Chapter 4 covers the mask process development, starting from pattern development to stripping and cleaning. The development process is explained and experimental results are presented. The processes of descuming, chrome etching, stripping/cleaning are described along with experimental results. The CD sensitivity to dose/exposure energy, development time and etching time has been studied and results are presented for both BF and DF masks. The evaluation of process was done on test structures/test masks and results are presented.

Chapter 5 describes the process validation by fabricating mask for SAW resonator, fabrication of SAW resonator and fabrication of SAW gas sensor for Sarin (DMMP). The CD results on fabricated mask, performance of SAW resonator and SAW resonator gas sensor for Sarin (DMMP) are described.

Concluding part of the thesis contains summary of the work carried out, Scope of Future Work and List of Publications.