4 Silicon-Based Microelectromechanical Systems (Si-MEMS)

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4.1 INTRODUCTION

Microelectromechanical systems (MEMS), also known as microsystems technology (MST), has seen an explosive growth during the past two decades. Miniaturizing technology with benefits such as new functionality, cost reduction, and space saving, has helped MEMS applications span over numerous fields including automotive, aerospace, photonics, telecommunications, life sciences, biochemistry, biology, biomedicine, and drug delivery to name a few. When it comes to sensors and actuators, MEMS is a strong competitor for the conventional manufacturing processes. Whenever a new functionality becomes possible by going small (e.g., biological applications), or when mass production at small scale reduces production costs (e.g., automotive applications), or when space is a major constraint (e.g., aerospace applications), utilizing MEMS becomes an obvious choice. This chapter focuses on Si-based MEMS with the main emphases placed on silicon properties, device fabrication, device applications, and the related mechanical and reliability related issues.

4.2 MATERIALS

4.2.1 SILICON

Silicon is the material of choice for most MEMS devices. This arises mainly from the economic benefits due to the well-established semiconductor manufacturing technology that provides the industrial infrastructure needed for MEMS fabrication. This is in addition to the desirable properties of silicon including electrical, optical, and mechanical, linked to various crystal structures. The well-established micromachining techniques with additive and subtractive processes make the design and mass production of Si-MEMS easy and economical. Si-based MEMS may have other materials that are compatible with silicon. These include silicon oxides, silicon nitrides, silicon carbides, and metals such as Al, W, Cu, and polymers such as polyimide.