Project Title: Micro-Electro-Mechanical System: Inertia Micro-Switch

Project Code: MW5-03

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Introduction

In today’s world switches are not only mechanical, but often have electrical components inside them. Some of the electrical switches depend on mechanical effect - inertia. These kinds of switches are mainly used in toys, accessories, automotive, and industrial applications. Because most of them are very small in size, they are called micro-fabricated inertia switches. The advantages of these switches are not only the miniaturization, but also their low cost production.

Because of their small size and because many can be produced in a short time, modern sensitive switches have the potential to replace conventional source materials of switches. In the project we studied and investigated the properties of sensitivity and application.

Aim and Objective

The first aim of the project was, after investigating the sensitivity of different thicknesses of the layers that form Micro Inertia Switches in order to determine how this affects the function of chip, to develop a Micro Inertia Switch.

The second aim was to design and build a PCB, with which the Micro Inertia Switch was joined in order to form a complete circuit.

The objective for doing so was to further reduce the size of the switches so that the quantity of used elements for making the switches could be minimized. The benefit of this is that production costs will be cheaper.

Circuit Board Diagrams

Bottom Layer View of Basic PCB Diagram

Top Layer View of Basic PCB Diagram
Preparing 4” N-type silicon wafers for fabrication

Sputtering metals onto the wafers

Using a mask to exposure and develop the patterns onto the wafers

Etching the unwanted metals away

Doing with similar processes until all the six masks had been used for fabrication

Fabrication Flow Chart

Micro-Inertia Switches Fabrication:

Pad

Untistick

Anchor

Seed layer

Beam

Mass
**Differences between Micro-Inertia Switches and the other switches**

- **Cost**
  Thousands of Micro-inertia Switches within a single layer of a wafer can be produced in one process. The dimension of an Inertia Micro Switch is about 1cm X 0.5cm. The thickness is about 0.1cm only. In one process, 25 Inertia Micro Switches can be produced. Traditional switches are produced one at a time and more time is needed for the process.

- **Sensitivity**
  If there is a small change in the inertia, they easily sense the change. The Inertia Micro Switches have different sensitivities, depending on the different situations in the process of making the switches.

- **Reliability**
  The Micro-inertia Switches are intrinsically more resistant against stiction-induced failures; more than 100 million contacts have been made, without any observable changes in the mechanical or electrical behavior. In contrast, traditional switches can only be used about 100 times.

**Advantages of using Micro-Inertia Switches**

Micro Inertia Switches are often used in toys. The advantage of the switches is that because they are smaller, they can be inserted into tiny toys in order to provide sound and light. When the switches detect any external motion, they turn on the circuit and the toy emits sounds and lights.

**Result and Discussion**

Our Micro Inertia Switches fall within the range 0.32 to 0.55 m/s for vertically driven and 0.34 to 0.53 m/s for laterally driven Micro-Switch.

The optimization of logic gate was accomplished. Only three standard logic gates were used for all the functions.

The fabrication process was successful. Different specifications of switches were made without any big problems. They were all very reliable after they were used a million times.

Further development of the project can focus on the application of Micro Inertia Switch. Besides toys and personal appliances, there are several aspects that can apply these switches such as domestic devices, automobile devices, and safety devices.