Project Report: Wheatstone Bridge Pressure Sensor

1. Introduction

This report details the design, fabrication, and testing of a Wheatstone Bridge Pressure Sensor, developed under the course EGN5013C: Introduction to Nanofabrication at Florida International University. The project aimed to fabricate a MEMS-based pressure sensor leveraging standard cleanroom-based microfabrication techniques.

2. Design and Layout

The Wheatstone bridge sensor consists of four resistive elements arranged in a bridge configuration to measure small changes in pressure. The layout was developed using LayoutEditor, and frontside and backside masks were designed for layered processing.

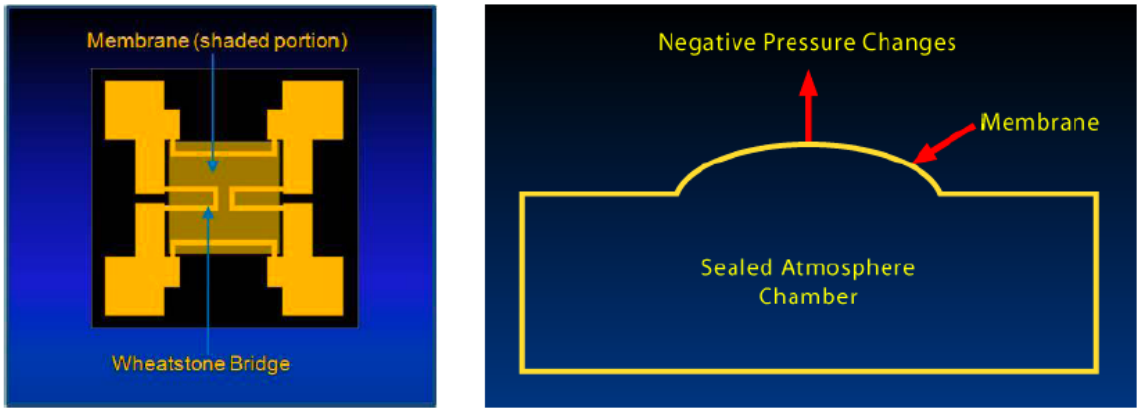

Figure 1: Pressure Sensor with a Wheatstone Bridge Configuration. Pressure sensor membrane.

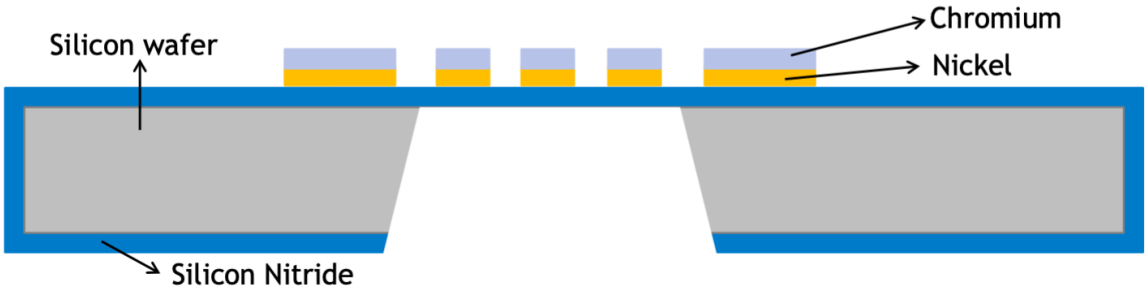

Figure 2: Cross-sectional view of the Wheatstone bridge pressure sensor

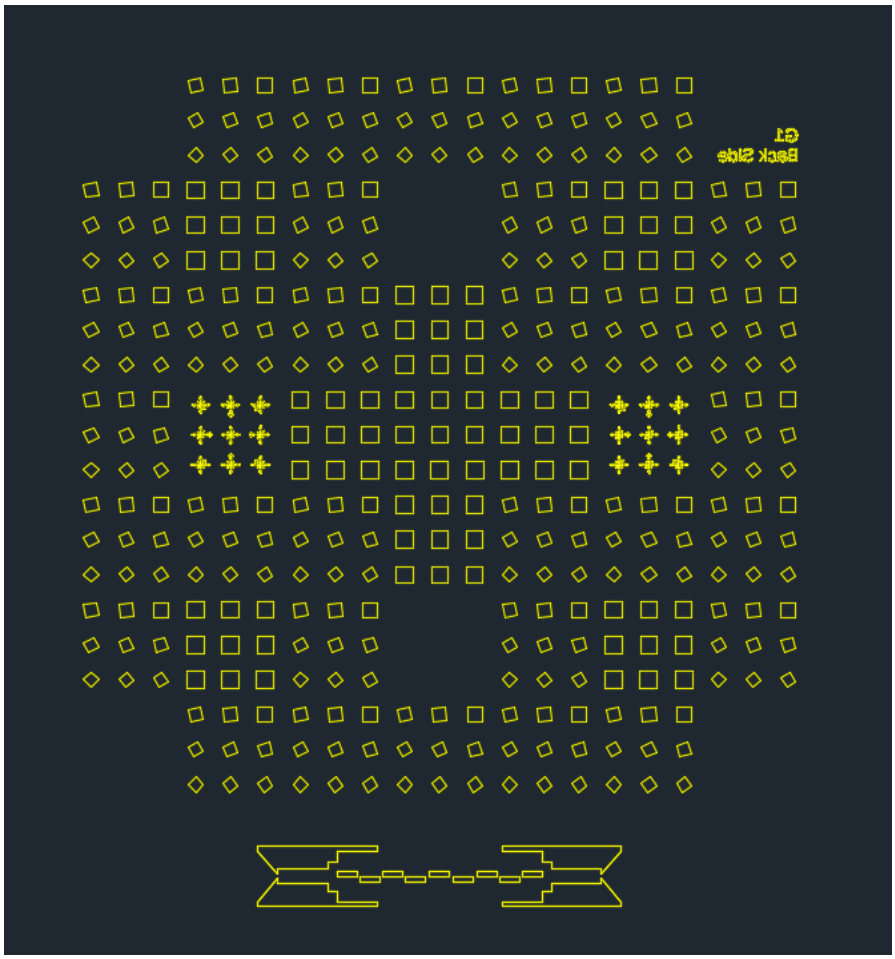

Figure 3: Backside Mask

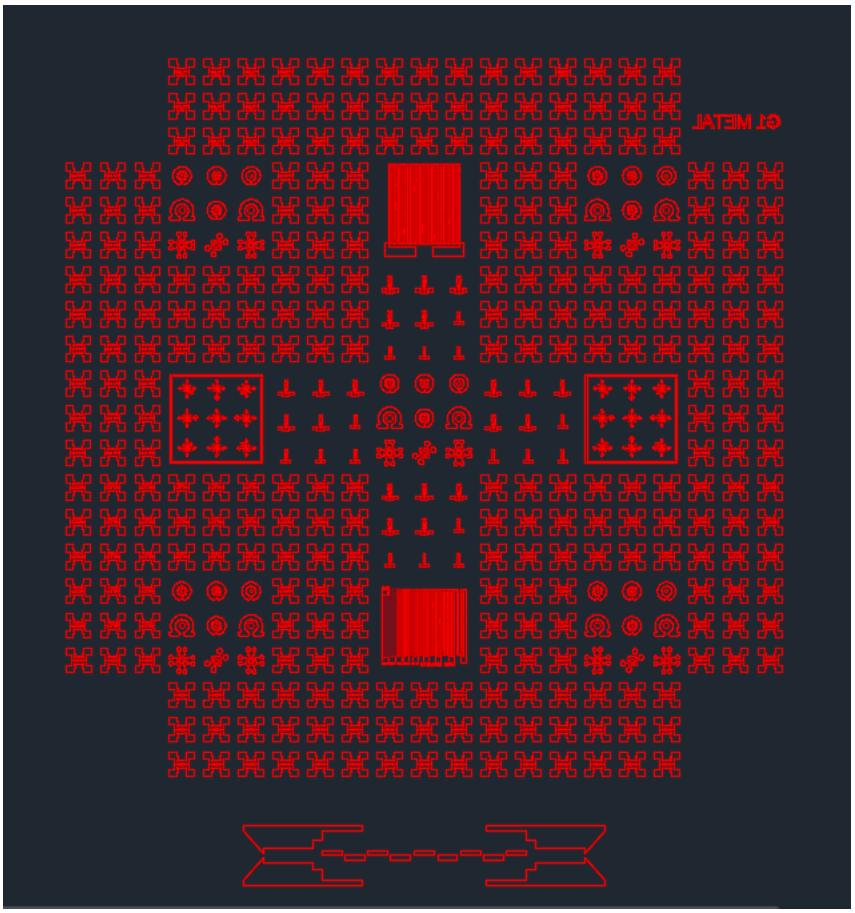

Figure 4: Frontside Mask

3. Fabrication Process

Fabrication took place in a Class 100 cleanroom environment. The major steps are outlined below and key tools used are shown in the following figures:

- Cleanroom Preparation: Class 100 cleanroom protocol
- Substrate Preparation: Spin coating using spin coater
- Lithography: Mask alignment using OAI Mask Aligner, Laser Lithography for mask writing
- Etching: Reactive Ion Etching (RIE) and Deep Reactive Ion Etching (MARCH DRIE)
- Thin Film Deposition: Sputtering, Evaporation (PVD), Plasma-Enhanced CVD (PECVD)
- Profilometry: Film thickness measurement using ALPHA STEP Profilometer
- Packaging: Bonding with wedge bonder

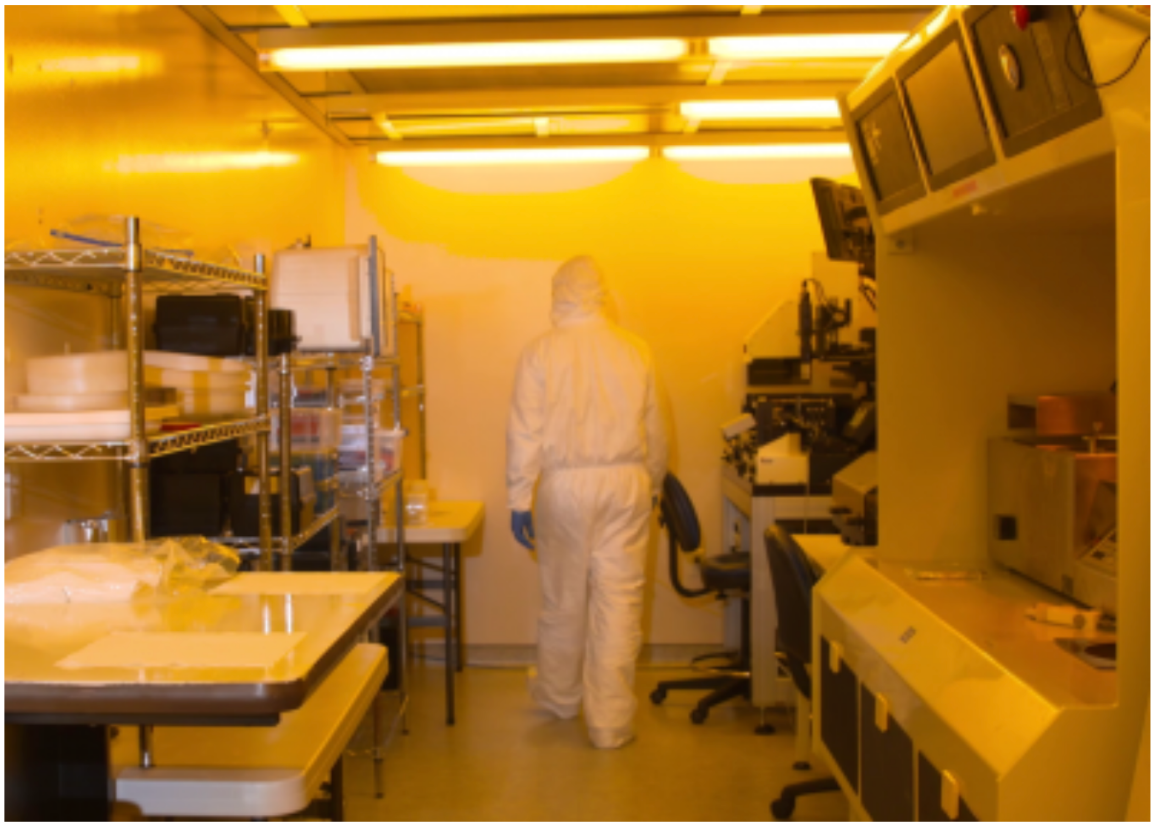

Figure 5: Class 100 Cleanroom

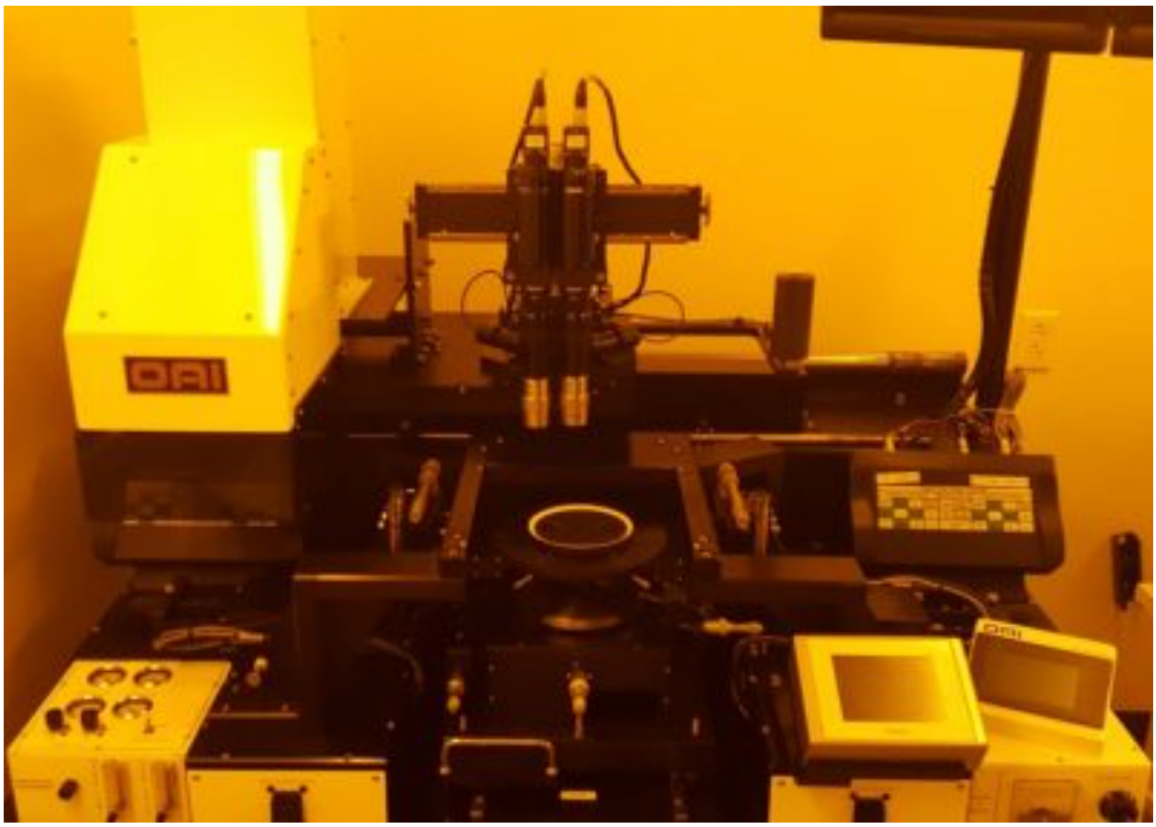

Figure 6: OAI Mask Aligner

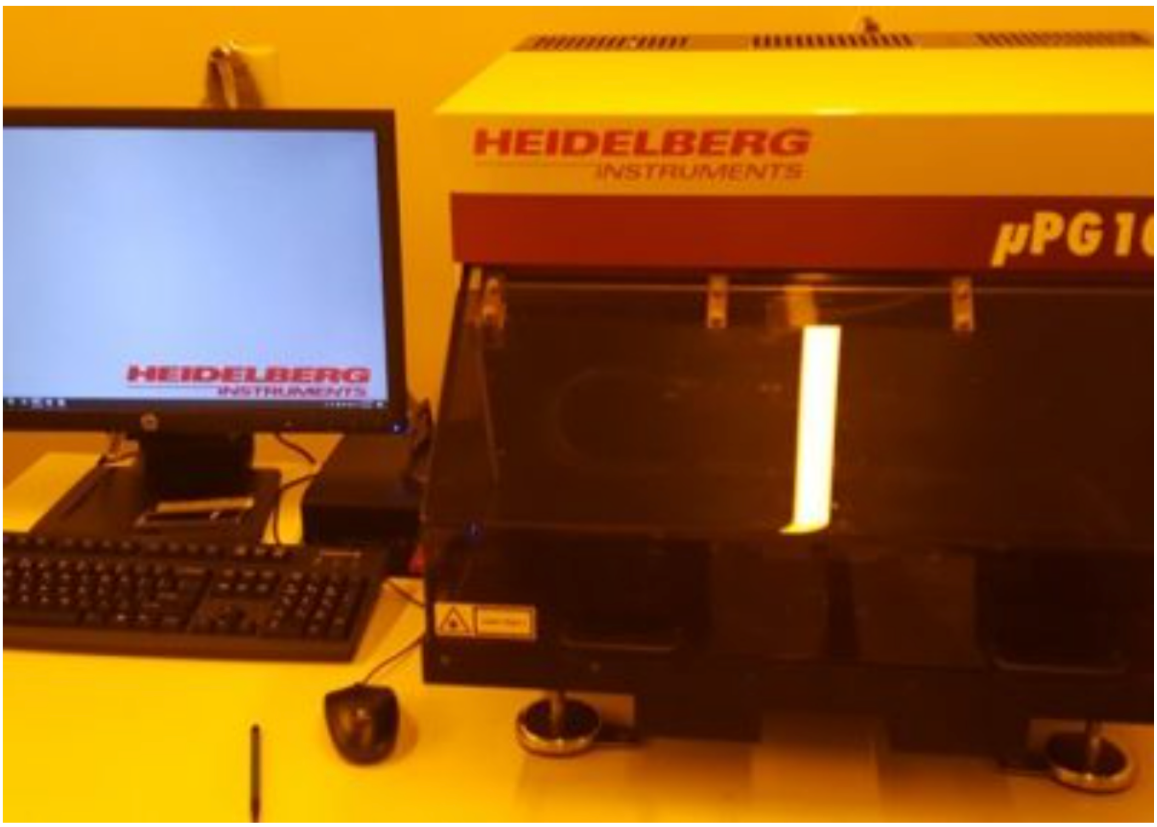

Figure 7: uPG Heidelberg 101 Laser Lithography System (Mask Writing)

Figure 8: Reactive Ion Etching

Figure 9: PVD Sputtering System

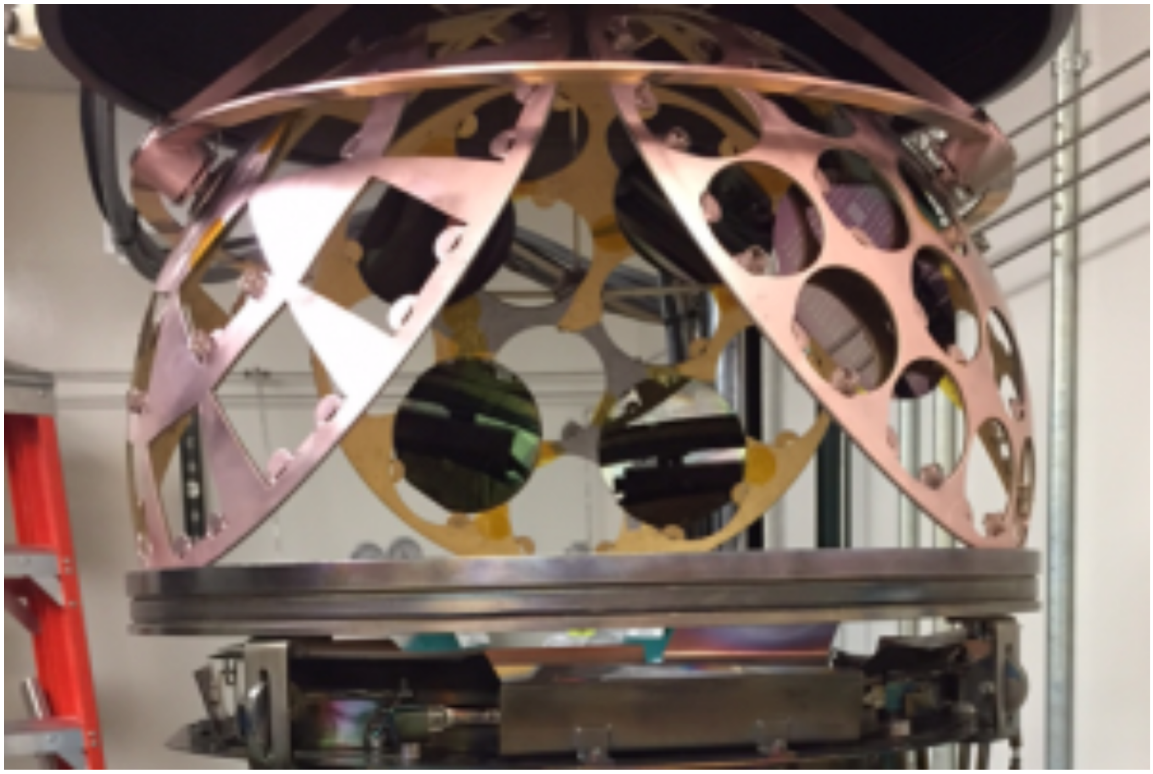

Figure 10: PVD Evaporation System

Figure 11: PECVD System

4. Testing and Results

Following fabrication, the Wheatstone bridge sensor was tested under varying pressure to validate its sensitivity and functional response. The change in resistance of the bridge arms was recorded and output voltage changes were measured to assess sensor performance.

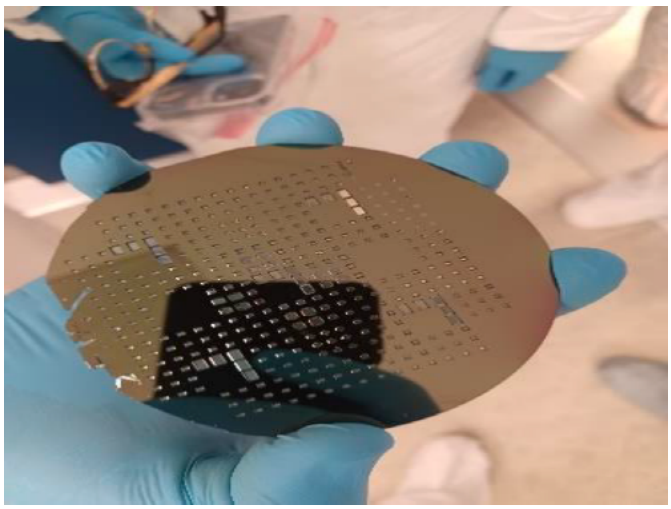

Figure 12: Wafer after bulk silicon etching

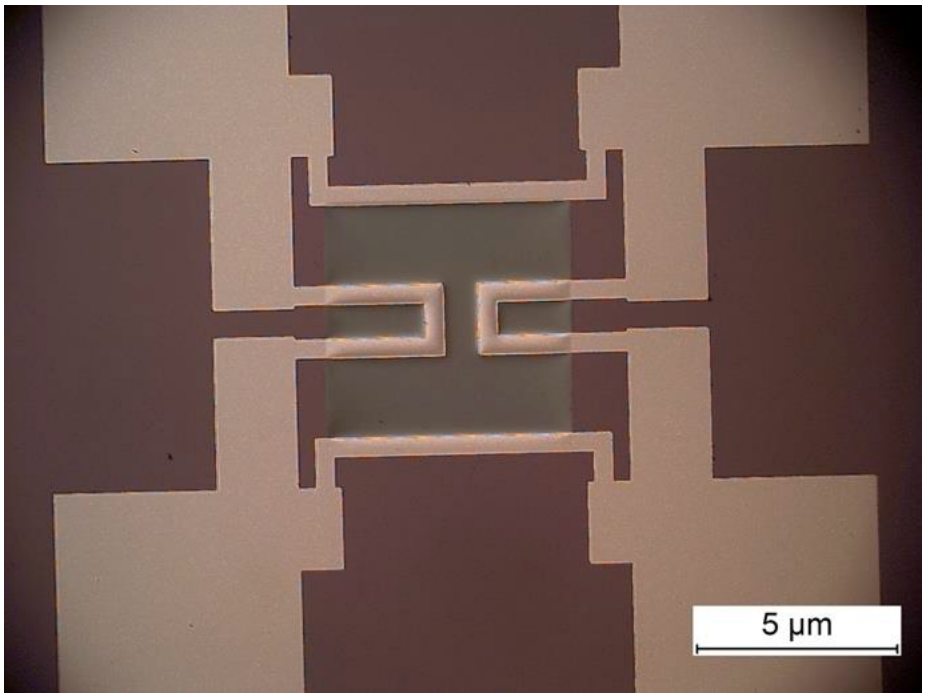

Figure 13: Wheatstone bridge with membrane

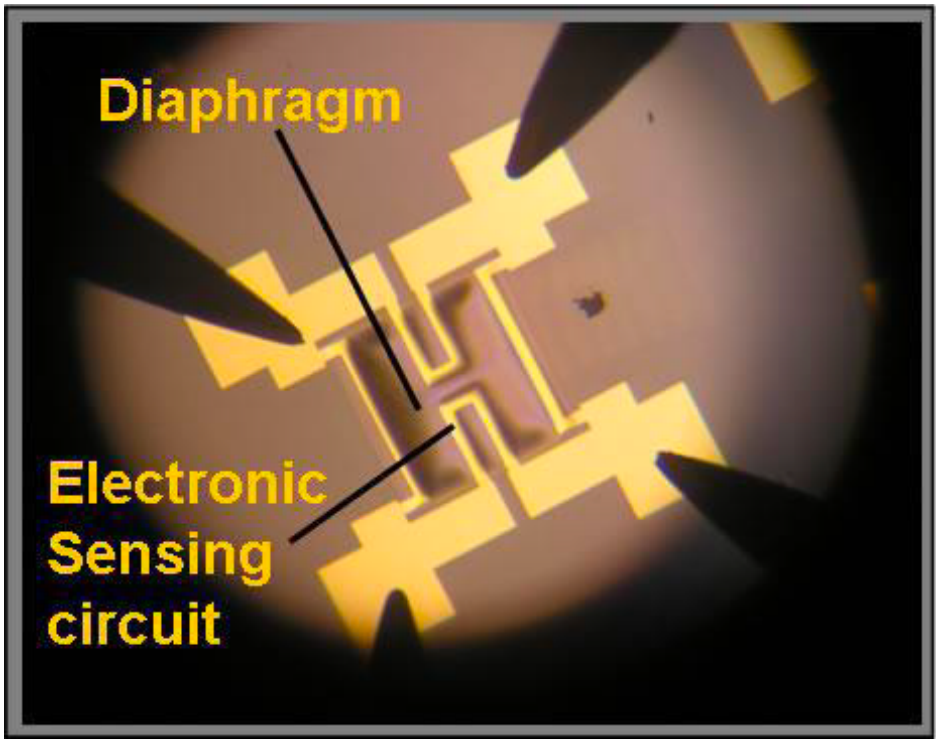

Figure 14: Pressure Sensor Testing.

5. Conclusion

The successful fabrication and testing of a Wheatstone Bridge Pressure Sensor provided deep insights into semiconductor fabrication, thin film deposition, lithography, and cleanroom protocols. This hands-on project not only reinforced microfabrication concepts but also strengthened troubleshooting and testing skills essential in the semiconductor and MEMS industries.