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Dalhousie University

ECED 6240

CMOS-MEMS

Lab. 1

Report

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Student

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Summary

The aim of this lab was to generate a schematic design, simulate its behavior and create device layouts using MEMS Pro tools. First of all, a lateral comb-drive resonator was designed using S-Edit following the steps of the tutorial provided to us. The tutorial was not updated so many of the steps had to be done in different ways in order to achieve the final scheme. For example, the insertion of global ports (ground or anchor) has a complete different procedure. After the structure scheme was finished the simulation of the device behavior was performed using T-Spice tool. Again, there are many differences between the tutorial instructions and the updated version of the software. Regardless of this fact, the conditions for the AC analysis were set up and simulation was successfully done. Then, the electrical and mechanical outputs of the nodes were visualised on graphics created with W-Edit tool. Most importantly, magnitude and phase graphics showed accurately the resonant frequency of the lateral comb-drive which is approximately 16.59 KHz. However, it was not possible to open the resonator file with L-Edit. The tutorial instructions did not work out and the student was not able to find out a way to do it. Finally, L-Edit tool was used to create a new design of a simple mechanical structure. In this case, a micro hinge was designed with PolyMUMPs process in agreement with the proper design rules. In conclusion, despite the difficulties towards using the new version of MEMS Pro, schemes, simulations and layouts were successfully accomplished.

1. Resonator schematic and simulation

The final scheme of the resonator and the displacement output of the plate are shown in Figs. 1 and 2, respectively.

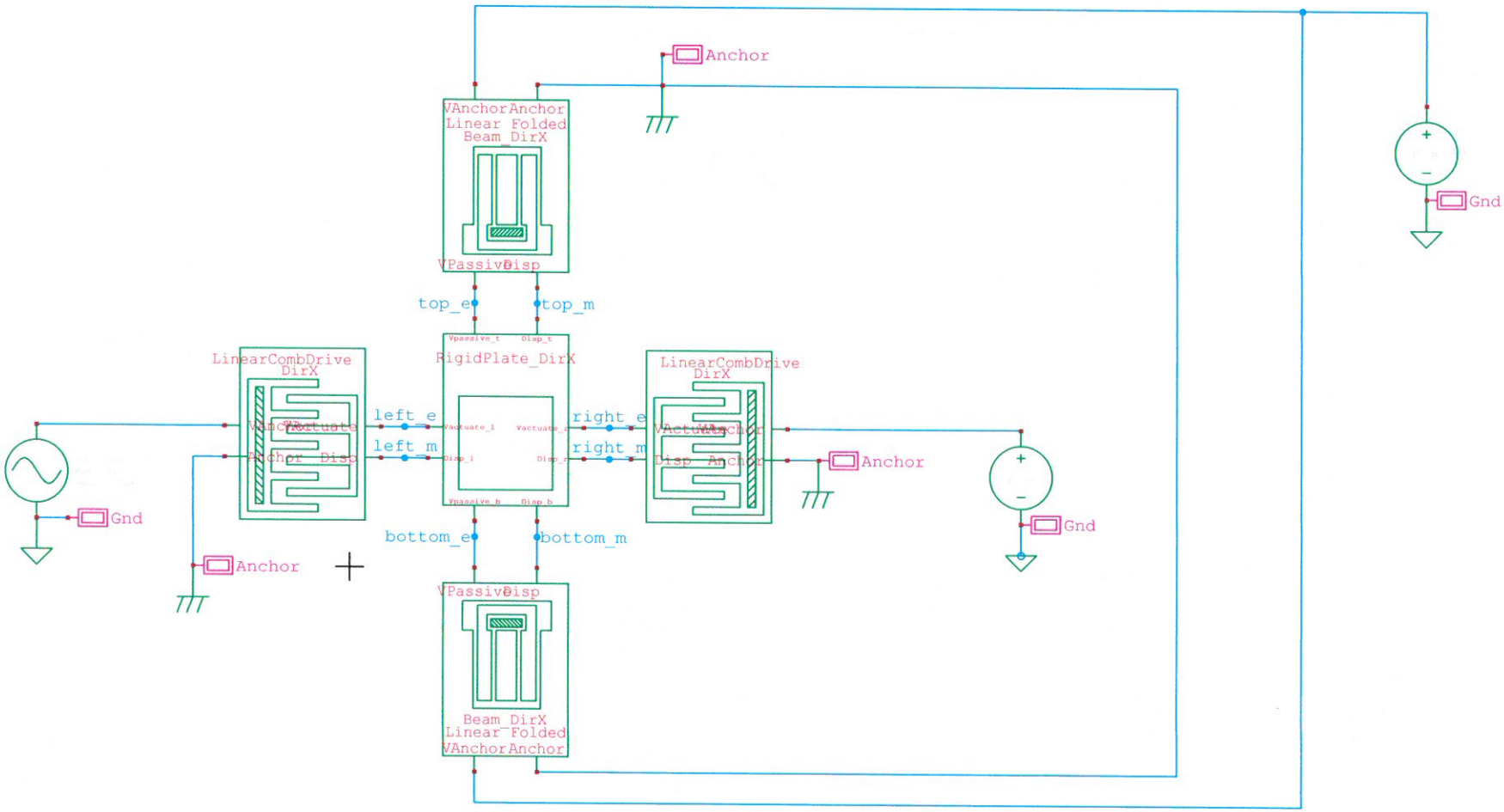

Fig 1: Schematic of the resonator.

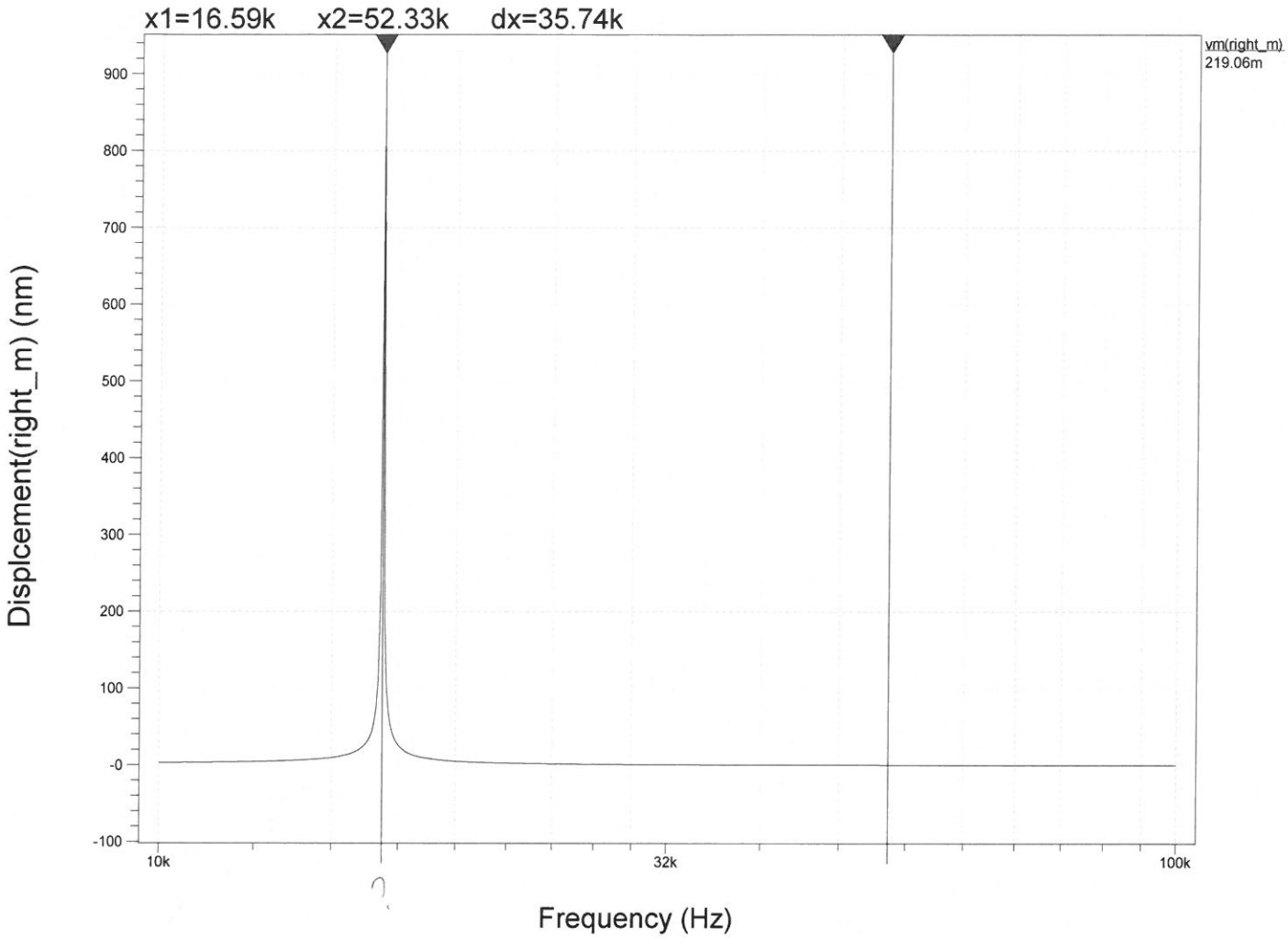

fig 2 : Displacement waveform.

2. Design of a simple mechanical structure

The design of micro hinge was done using L-Edit tool and PolyMUMPs layers. A new layout of a simple mechanical structure was created using L-edit. A micro hinge was the chosen structure to be designed and all the PolyMUMPs layers (except metal) were used to create the layout. The hinge has a movable beam that can rotate in relation to y axis while an anchor fixes the structure on the bottom layer (Fig. 3). Next subsections will describe the hinge's layers and show its dimensions and the design rules that were used.

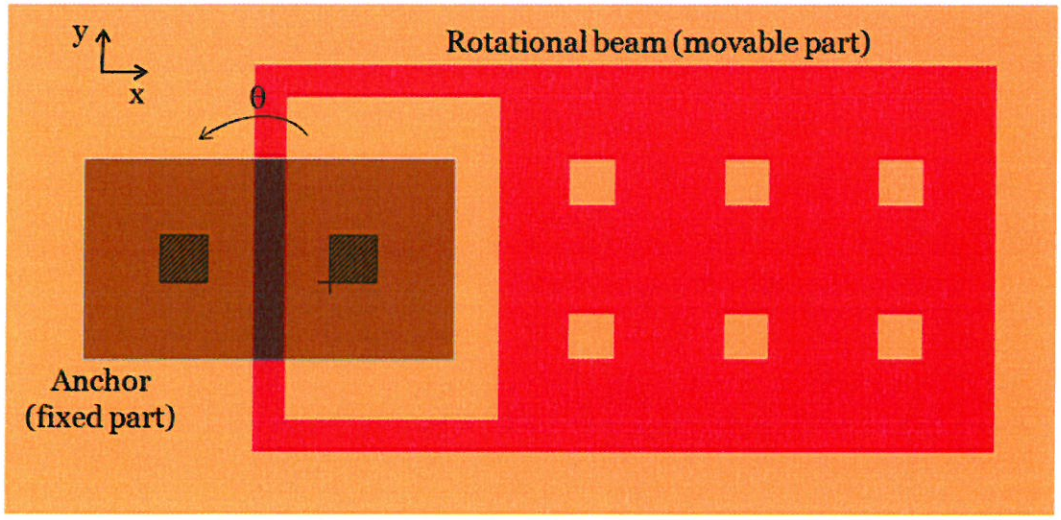

Fig 3: Micro hinge designed in L-edit.

2.1 Layers

PolyMUMPs is a microfabrication process used to produce MEMS structures. PolyMUMPs makes use of 7 layers including 2 structural layers (polysilicon 1 and 2) and 2 sacrificial layers (Oxide 1 and 2). The sequence and the dimensions of the layers can be seen in Fig.4. The hinge design in Fig. 5 shows the name of each layer and levels used. Anchor 2 connects Poly 2 to the substrate while Hole 1 is an opening made in the Poly 1 in order to intensify the etching of the sacrificial layer underneath it. Finally, Fig. 6 presents the cross-section of the hinge design.

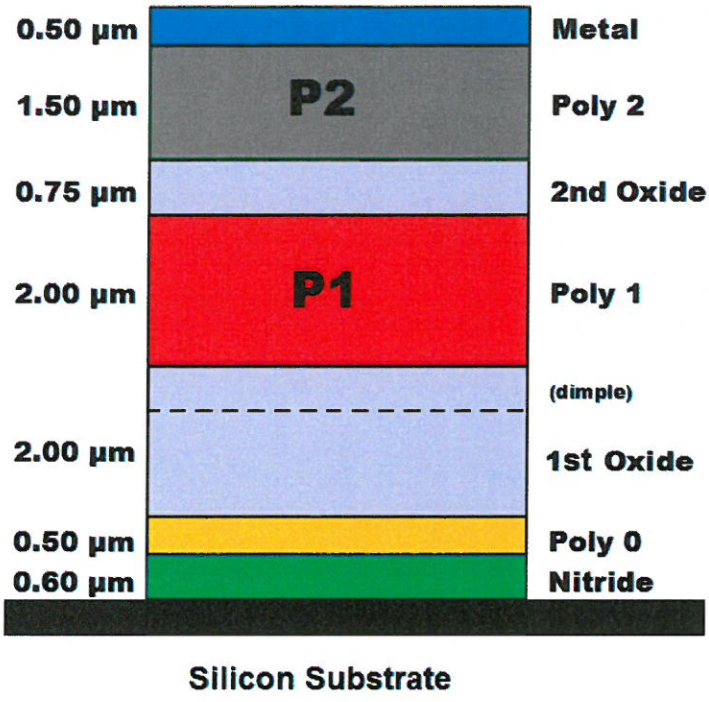

Fig. 4: PolyMUMPs layers.

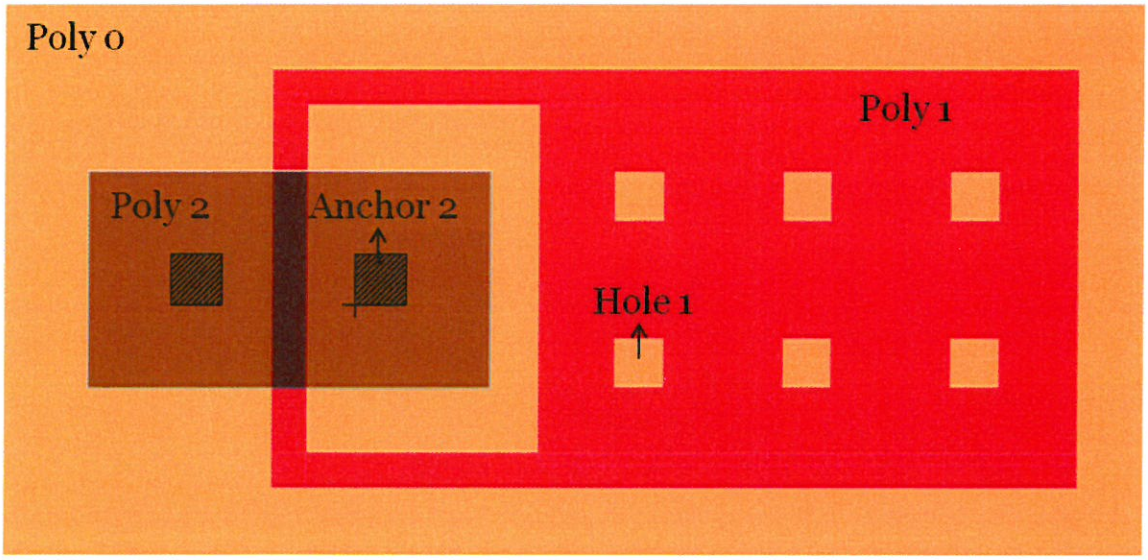

Fig. 5: Layout of the structure with layers and levels names.

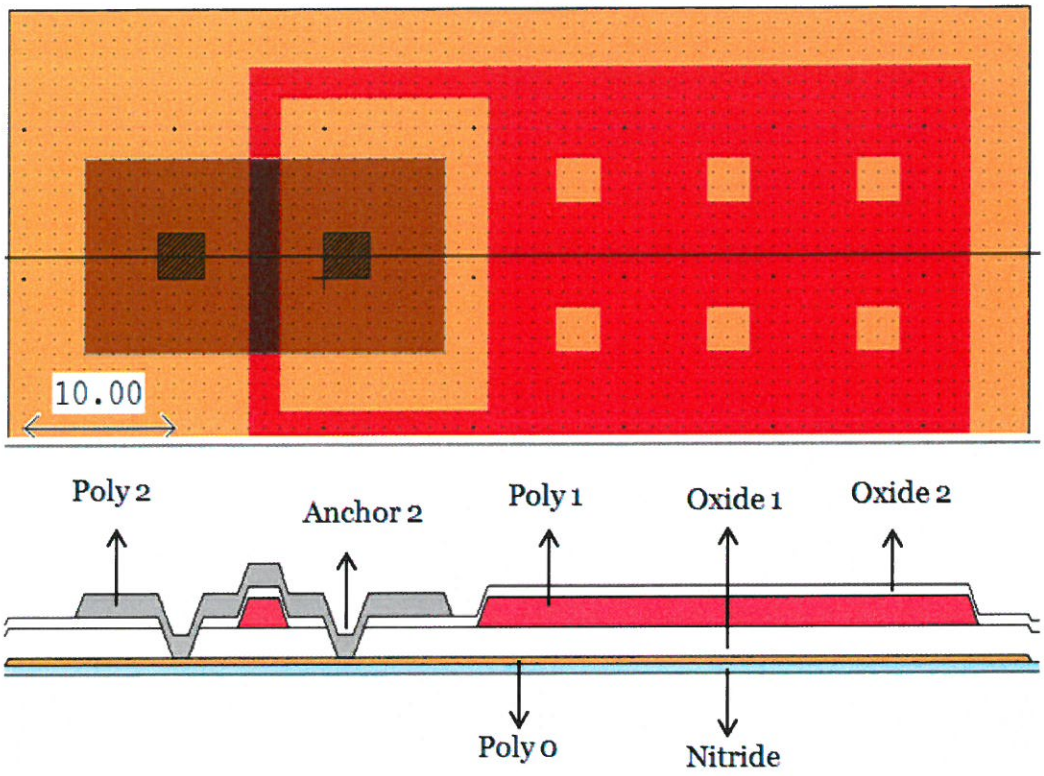

Fig. 6: Cross-section of the final structure.

2.2 Dimensions and design rules check (DRC)

The design rules used are described next. Their numbers in the list correspond to their locations on the structure showed in Fig. 7.

1. Minimum feature for Poly 1
2. Poly 0 enclose Poly 2
3. Poly 2 enclose Anchor 2
4. Minimum spacing between Anchor 2 and Poly 1
5. Minimum feature for Anchor 2
6. Minimum spacing between Poly 1 and Poly 2
7. Minimum feature for Hole 1
8. Poly 2 cut-out Poly 1
9. Poly 0 enclose Poly 1

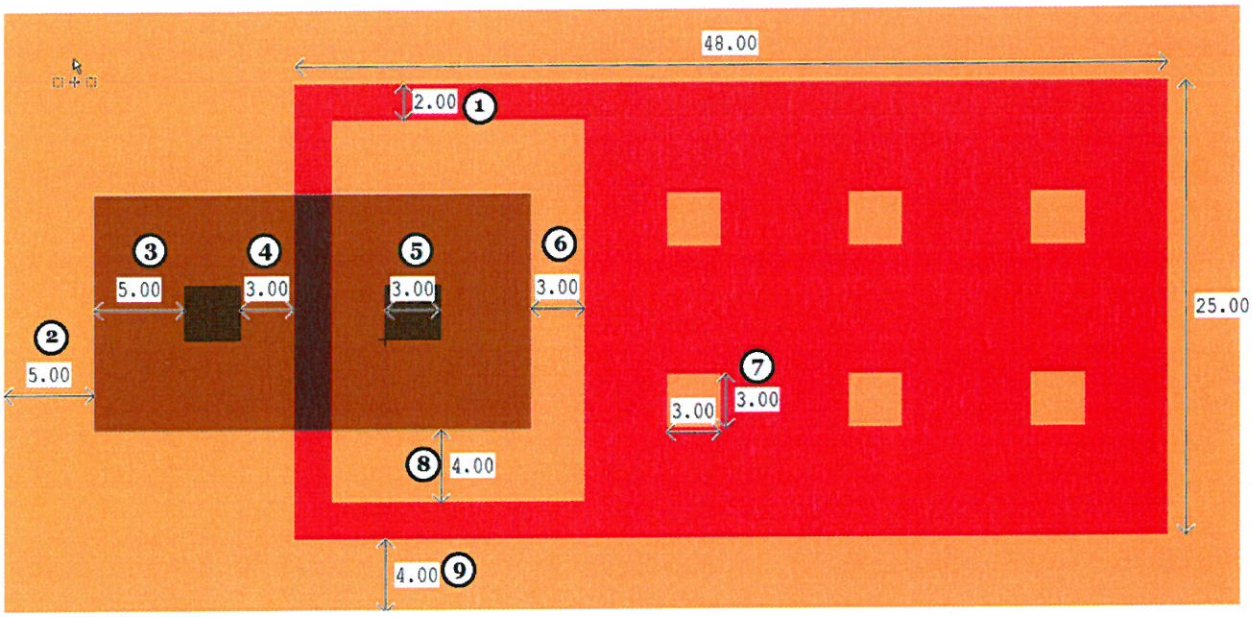

Fig. 7: Dimensions and DRC of the design.