Modeling and simulation of piezoresistive pressure sensor for 2bar application

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Introduction: Pressure sensors have the largest share in the global market of MEMS-based sensors. This work summarizes the modeling of a piezoresistive pressure sensor with COMSOL.

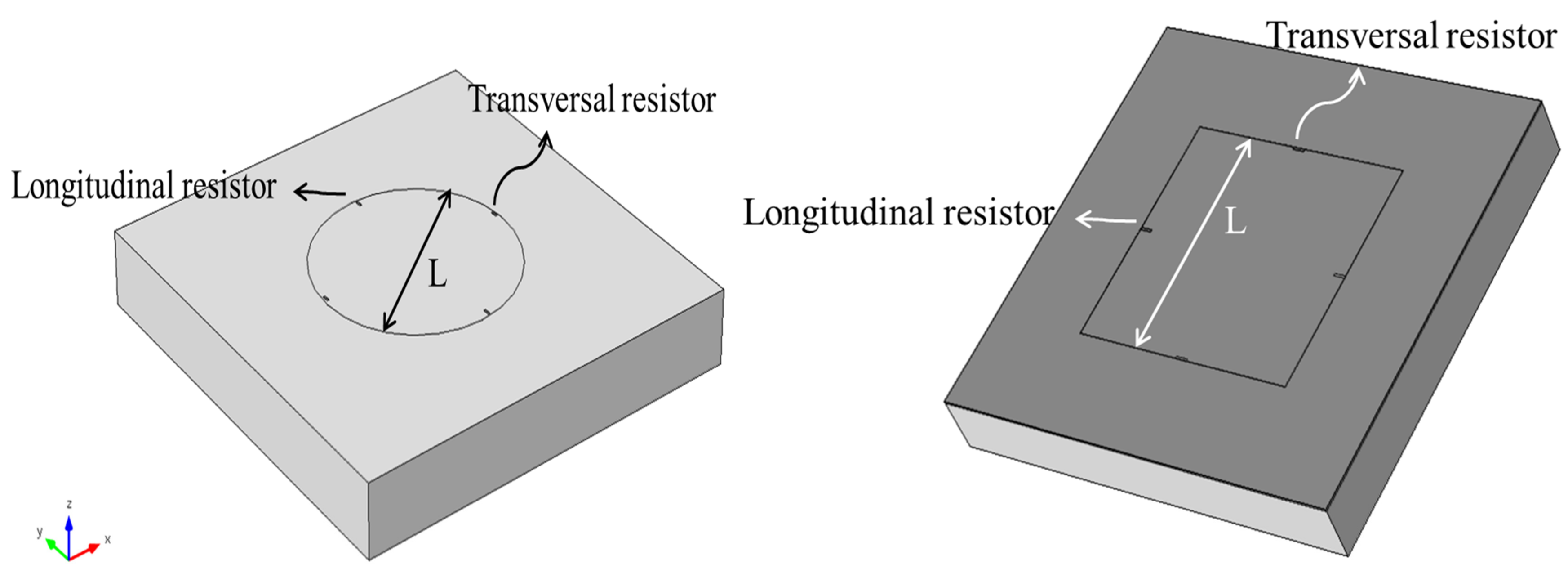

Figure 1. Comsol model of MEMS piezoresistive pressure sensor with round and square membrane

Computational Methods: In piezoresistor, the strain induces change of the material's band structure, leading to variation in carrier mobility and number density. The relation between the electric field, E, and the current, J, within a piezoresistor is:

$$E = \rho.J + \Delta\rho.J$$

$$\Delta\rho = \Pi.\sigma$$

where ρ is the resistivity, Δρ is the induced change in the resistivity and Π is the piezoresistance tensor ($Pa^{-1}\Omega m$).

The thickness of silicon membrane, H, is 15µm and the length of membrane, L, was varied from 500µm to 1500µm. The supply voltage of 5V is applied to the bridge and the differential output voltage of the bridge was calculated over a pressure range of 0bar to 2bar.

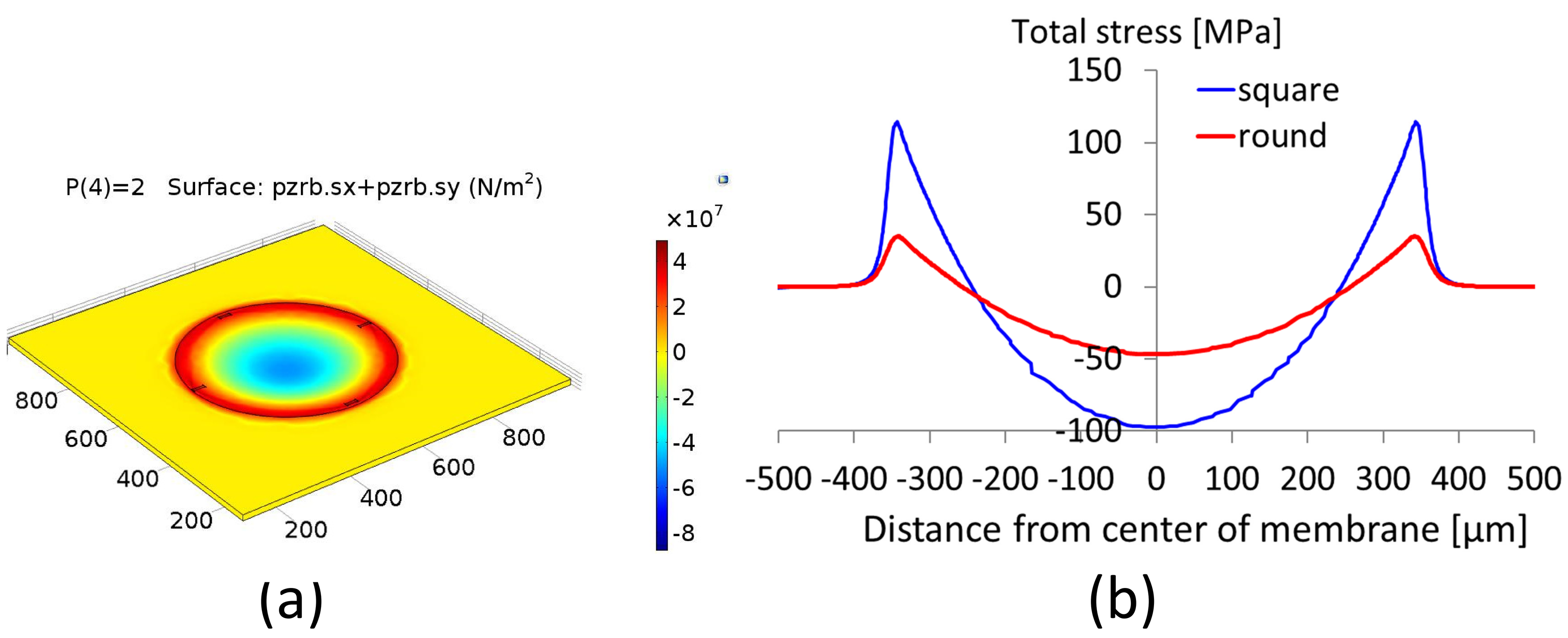

Figure 2. (a) Comsol 3D plot of surface stress of round sensors (b) Stress profile of square and round shape pressure sensors when a 2bar pressure is applied.

Results: We investigate the impact of the membrane shape and size on the sensor performance using the COMSOL model. Nonlinearity and sensitivity as the most important parameters of sensor were extracted.

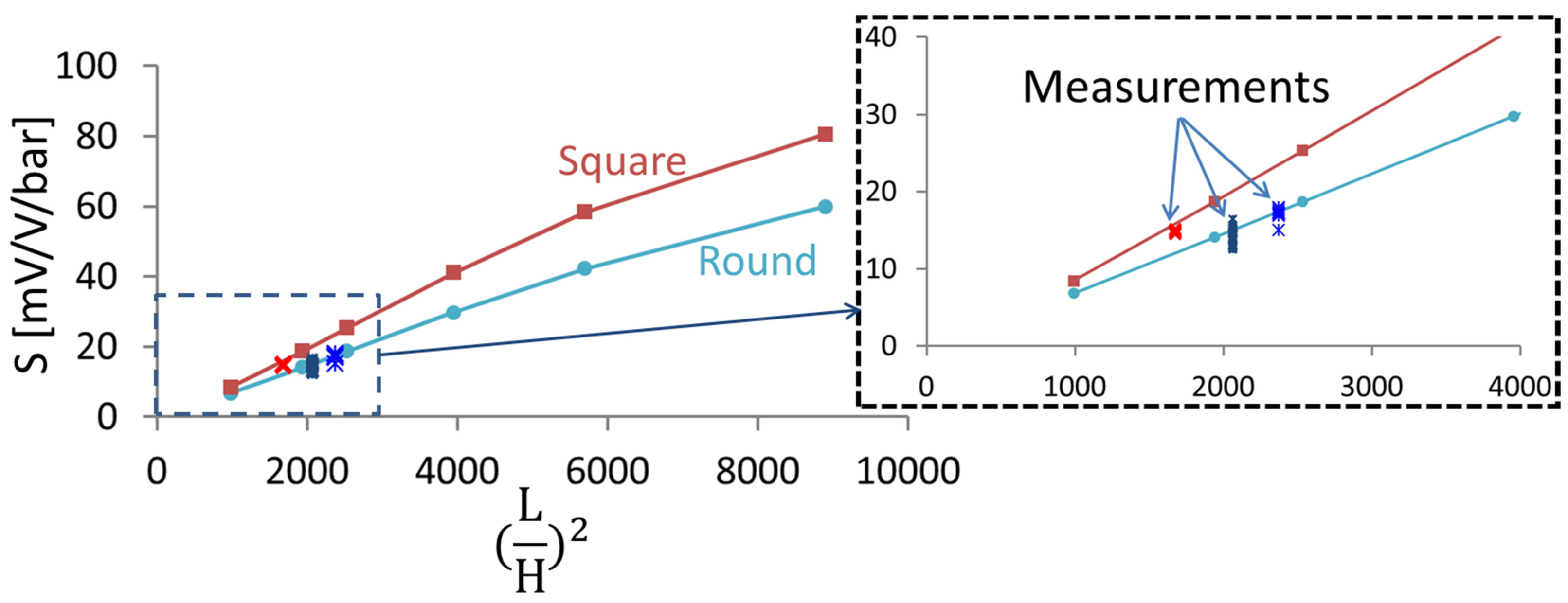

Figure 3. FEM analysis results for sensitivity of sensor

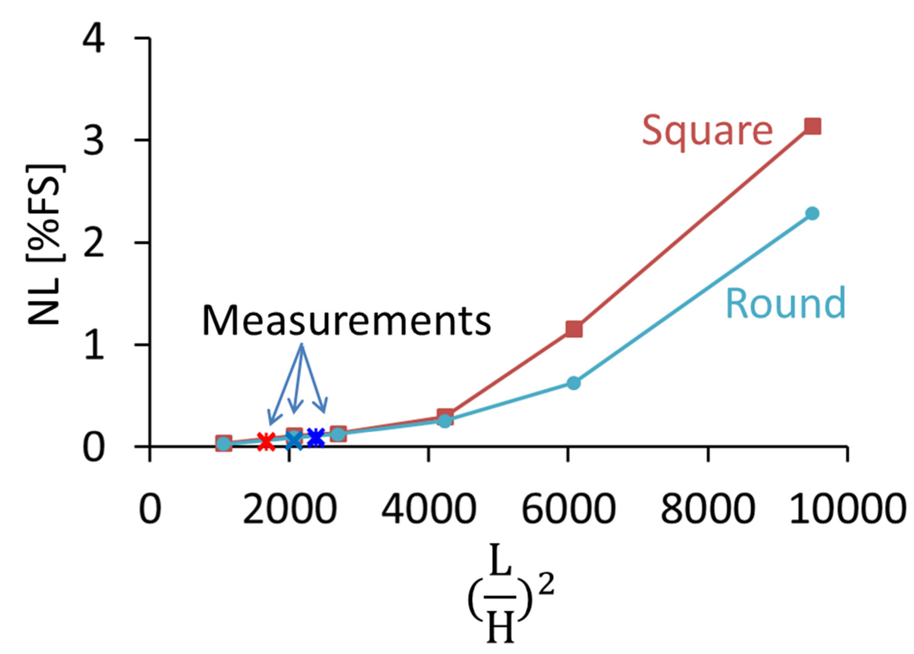

Figure 4. Nonlinearity of pressure sensor

Conclusions: It was shown that the sensitivity and nonlinearity of the square shape membranes are larger than circular ones. Therefore depending on the application, either round or square shape can be chosen for the sensor membrane and COMSOL modeling can help us to make a wiser choice for both the shape and the size of the membrane.

References:

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