Capacitive accelerometer characteristics study
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Introduction: To study the effect of the physical dimension and material property on the characteristics of a MEMS capacitive accelerometer such as frequency response, dynamic range, sensitivity and temperature range.

Results: Four different accelerometer dimensions and the materials simulated in this paper are tabulated in Table 1.

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<tbody>
<tr>
<td>Upper plate Design-1,2,3,4</td>
<td>1000,1000, 1000, 1000</td>
<td>600,600, 600,600</td>
<td>5,10, 5,10</td>
<td>Nickel, Ni, NiNi</td>
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<tr>
<td>Springs Design -1,2,3,4</td>
<td>8,10, 8,10</td>
<td>100,150, 100,150</td>
<td>5,10, 5,10</td>
<td>Si, Si, PDMS, PDMS</td>
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</tbody>
</table>

Figure 1: Top view of capacitive accelerometer

Computational Methods:

Acceleration due to gravity g is applied to the top surface of the sense element and simulated. Sensitivity, frequency response, dynamic range and temperature range of the accelerometer is measured. Error in experimental capacitance value with respect to theoretical calculation is measured.

Theoretical analysis

The capacitance is calculated using equations 1 and 2.

\[
C_{12} = \frac{\varepsilon_0 \varepsilon_r A}{d + \delta} \quad (1)
\]

\[
C_{13} = \frac{\varepsilon_0 \varepsilon_r A}{d - \delta} \quad (2)
\]

Where, \(\delta\) = Deflection of the beam [m/g].

Sensitivity is given by,

\[
Sensitivity = \frac{\Delta C}{g} = \frac{|C_{12} - C_{13}|}{g}
\]

Table 1: Design dimensions and materials used

Figure 3: \(C_{12}\) versus g

Figure 4: \(C_{13}\) versus g

Table 2: Design comparison table

Conclusions:

From table 2 we conclude that Design 2 is the optimised design for the basic accelerometer model. This paper has made an attempt to understand the material and physical dimension dependence on accelerometer characteristics.

References:

3. www.silicondesigns.com