Deformation Examination of Circular Membrane by Model for PDMS from Sylgard 186

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Introduction: The aim is to determine the deformation of one dot of tactile display for visually impaired. The dot is a circular membrane, made from a rubber-like material, namely Sylgard 186.

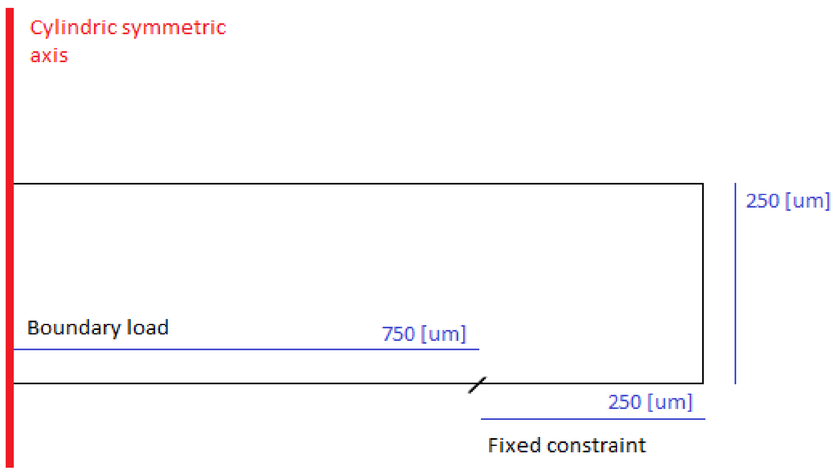

Figure 1. 2D axisymmetric geometry and boundary conditions

Computational methods: In the FEM model hyperelastic material model was used. The Ogden model proved to be the most appropriate material model.

M-order Ogden model:

$$W(\lambda_1,\lambda_2,\lambda_3) = \sum_{i=1}^{M} \frac{\mu_i}{\alpha_i}\cdot\left(\lambda_1^{\alpha_i}+\lambda_2^{\alpha_i}+\lambda_3^{\alpha_i}-3\right), \quad where\ \ \alpha_i\cdot\mu_i > 0$$

M-order Ogden model for simple tension:

$$t_s^M = \sum_{i=1}^{M} \mu_i\cdot\left(\lambda^{\alpha_i-1}-\lambda^{-\frac{\alpha_i}{2}-1}\right)$$

Determination of Ogden parameters:

- Simple tension measurements with dumbbell shaped specimens (standard: ASTM D412)
- Using Optimization Toolbox (Matlab) for curve fitting
- In the first order Ogden model the magnitudes of nominal stresses show significant deviation
- Second order Ogden model applied

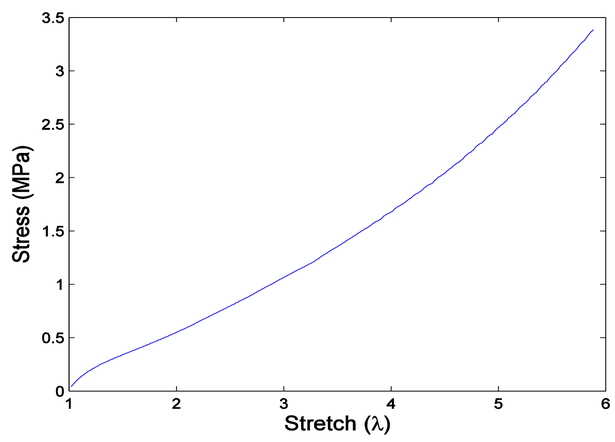

Figure 3. Typical Strecth – Nominal stress curve

Figure 2. Moulded dumbbell specimens before trimming

COMSOL model requirements:

- Nonlinear Structural Materials Module
- 2D axisymmetric geometry
- Parametric sweep for different pressures
- Maximum achieved pressure: 1.8 [bar]
- Modified boundary load was applied to eliminate error causing by the corner

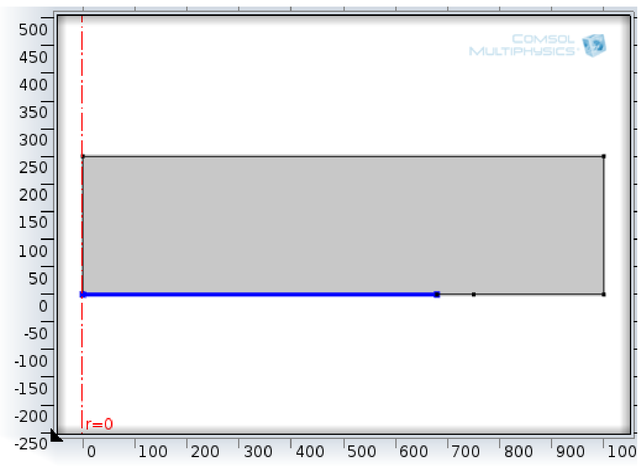

Figure 4. Modified boundary load

Results:

- The results of displacement implies buckling phenomena
- Maximum displacements at 2 [bar] pressure is ~800 [um]

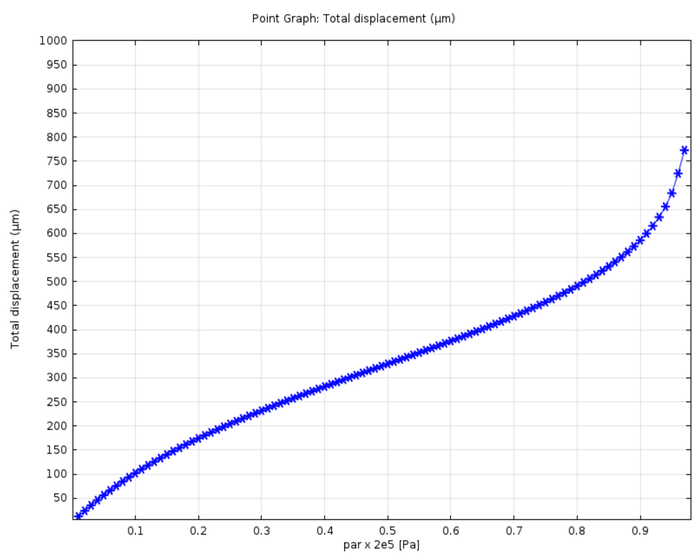

Figure 5. Total dispalecement (in [um]) in case of modified boundary load

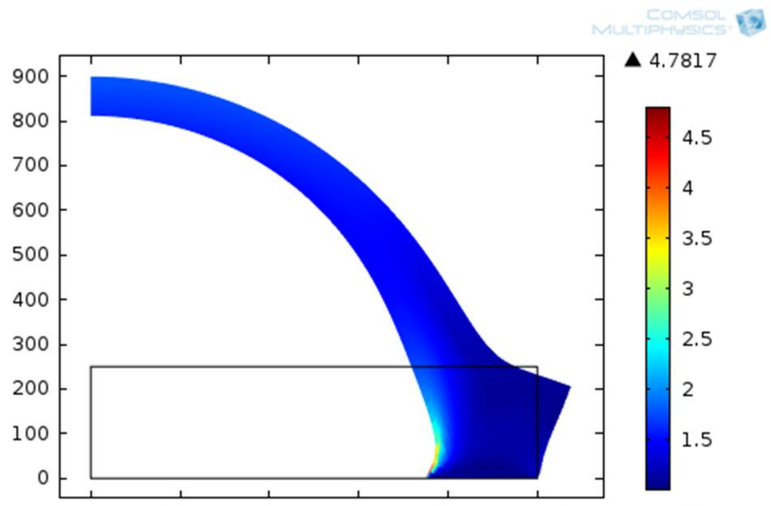

Figure 6. First principal stretch in case of 1.8 [bar]

Conclusions:

- Good approximation in order of magnitude for displacement of one dot
- Further measurements (at least one other kind) are necessary for more precise results

→ Second order Ogden model's parameters getting more accurate

References:
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