Deformation Examination of Circular Membrane By Model for PDMS From Sylgard 186

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Abstract

In this research the deformation of one dot of tactile display for visually impaired is examined by Finite Element Method (FEM) in COMSOL Multiphysics® software. A dot with rubber-like material can be described by a circular membrane with hyperelastic material model. The chosen hyperelastic material model is the Ogden model, which is in present case incompressible isotropic elastic strain-energy function. The material of the membrane is Polydimethilsiloxane (PDMS) from Sylgard 186 for which there are not determined the parameters of hyperelastic Ogden model in the literature so far. For setting up the FEM model, determining the parameters of the Ogden model was necessary, for which simple tension test was applied on the appropriate dumbbell specimens prepared from Sylgard 186. For first and second order Ogden models were also executed the curve fitting to determine the parameters by functions of MATLAB® based on nonlinear least squares optimization. The specific case is the second order Ogden model, finding the appropriate four parameters causes difficulties because of the highly nonlinearity of the models function. The retaining of the same magnitude of the simple and equibiaxial tension models and the model of the pure shear mean some support in determination of the parameters. Despite of making the parameter range shorter, the right parameter-four for the second order Ogden model cannot be determined unambiguous, so the conclusion is that for assessing at least one other second address kind of measured data set is necessary, such as equibiaxial tension test or displacement of the top of the dot.

The displacement of a dot's membrane was examined by Ogden model, which proved to be the most appropriate hyperelastic material model for rubber-like study. Making hyperelastic material modelling in COMSOL Multiphysics® requires Nonlinear Structural Material Module. The dot was modelled in 2d axisymmetric geometry for different pressure, which were increased by Parametric Sweep. One of the main difficulties was caused by the corner of the membrane's fixed part: because of its stress collector behavior modified boundary condition had to be chosen.

In this research the deformation of a 250[µm] membrane is examined by hyperelastic Ogden model using FEM models. Tension test was executed for PDMS from Sylgard 186 and by that the necessary parameters for Ogden model were determined, which are not in the literature so far. Current results could be considered good approximation in order of magnitude for displacement of one dot, but for further clarifying the buckling phenomena in the results of the FEM model at least one more other kind of measurement is necessary. That could make the appropriate second

order Ogden model's parameters more accurate. Two kinds of measurements could emerge: first is making equibiaxial tension test and second is measuring the displacement of the top of circular membrane.

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Figures used in the abstract

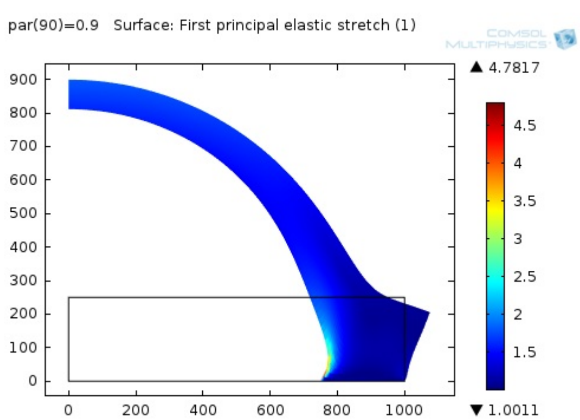

Figure 1: First principal stretch in case of 1.8 [bar] pressure.

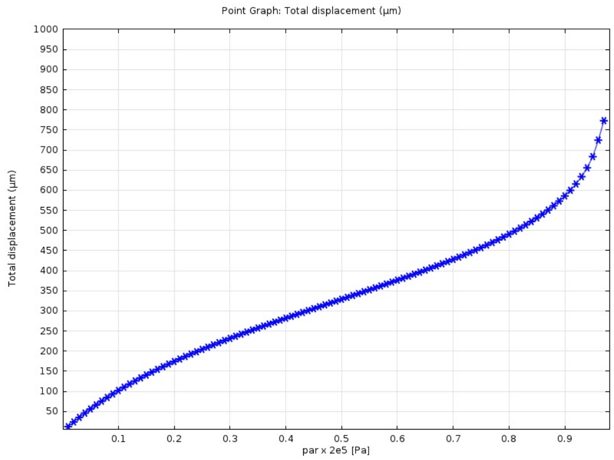

Figure 2: Total displacement in case of modified boundary load.