Modeling of Direction Dependence in Nanowire Flow Sensor

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Abstract

Microelectromechanical devices have been widely used these days concurrently with the decades' fast development in the micro- and nano-electromechanical system (MEMS/NEMS) technology. Availability of a reliable and robust micro-scale gas flow sensor has proven to be an important requirement in these MEMS devises. Current study is focused on modeling a novel form of multi-directional gas flow sensor which is designed by utilizing a Si nanowire array and its piezoresistive properties to change conductivity upon flow pressure on the sensor material. Finite element analysis (FEA) model constructed using COMSOL Multiphysics® software has been used for modeling piezoresistive phenomena in the nanowire array. Figure 1 shows the single nanowire model with different gas flow directions that has been used in the current study. Constructed model consists of three types of physics coupled together, fluid flow and structural mechanics (Fluid Structure interaction) and piezoresistivity (MEMS Module). 3D FEA model of p-type silicon nanowire has been constructed and tested for multiple variables such as induced stress tensor, induced voltage and electric field with varying gas flow direction in the channel. Parametric study has been used to analyze the flow direction dependence of the induced stress/voltage of the sensor. From figure 2 it shows the gas flow direction dependence of induced stress values (σxz and σyz) in the base of nanowire. Flow direction dependence of induced voltage and electric field in piezoresistive material will be calculated and included in the study. Current results show that the anisotropic properties of the material can be successfully used in the gas flow sensor to differentiate between flow components in different directions.

Reference

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Figures used in the abstract

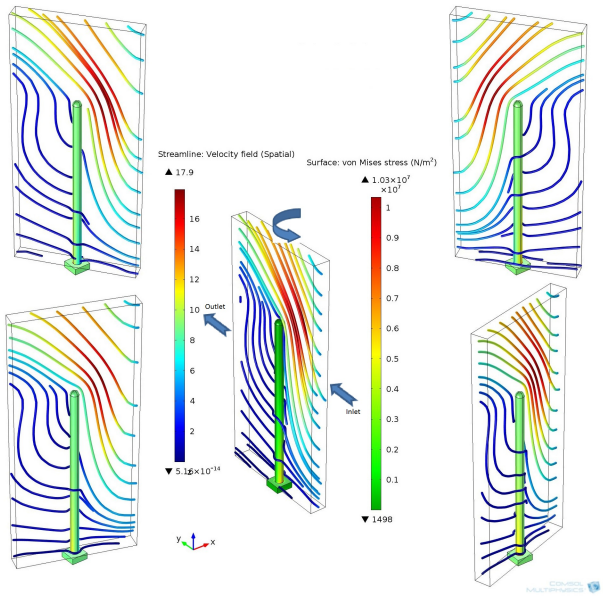

Figure 1: Single nanowire model with changing gas flow direction.

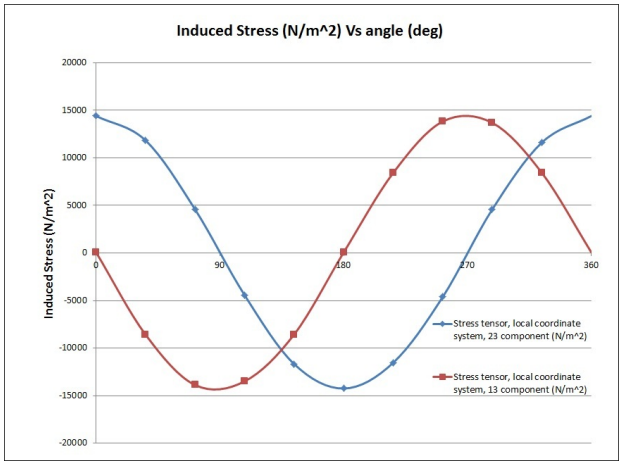

Figure 2: Flow direction dependence of induced stress.