# ELECTROCHEMICAL CAPACITANCE-VOLTAGE TECHNIQUE TO CHARACTERIZE DOPING PROFILES OF SILICON NANOWIRES GROWN BY ELECTROLESS ETCHING

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In recent years, silicon nanowires have been finding use in sensing applications for biomedicine and in many other fields [1]. The electroless etching of silicon (Si) is one of many ways to fabricate silicon nanowires (SiNWs). This is one of the simplest and least expensive mechanisms for growing SiNWs [2]. Sensing SiNWs require doping to make a p-n junction which is a solid state thermal process. Functionality of nanowires is achieved by diffusing impurities after they have been fabricated. In order to know how the depth and concentration of electrically active dopants effect the performance of the nanowires, we need to plot its doping profile.

Doping profile characterization in a doped semiconductor can be done through capacitance-voltage (CV), spreading resistance profiling (SRP) and secondary ion mass spectroscopy (SIMS). Because of their morphology of SiNWs, SRP and SIMS cannot be used for the doping profile characterization. By using a variation of the CV technique known as electrochemical capacitance voltage (ECV) [3], it is possible to plot profile depth of SiNW's. The measurement setup is similar to that used in conventional CV except that the Schottky contact is made through an electrolyte which acts as an etchant. This way the profile depth can be increased by etching through the silicon nanowires instead of increasing the bias voltage. In the present research, the ECV technique is used to obtain doping levels and layer thicknesses of impurities (diffused at different temperatures) on silicon nanowires. Poisson's equation was used along with Gauss's Law, the capacitance is derived for the expected doping density $N_d(X_d)$ at the depletion depth $X_d$ in the silicon nanowires [3].

$$N_d(x_d) = \frac{1}{q\epsilon(x_d)A^2} * \frac{C^3}{dC/dV}$$

$$x_d = \frac{\epsilon(x_d)}{C}$$

In this experiment, p-type <100> Si, resistivity 10 Ω-cm is used, cut into one inch square pieces. SiNWs were grown on samples by electroless etching process to achieve an average diameter of 50 nm [4]. Phosphorous diffusion is performed at different temperatures (800, 825, 850, 875 and 900 C). For this profiling experiment an electrochemical cell is used, made with Plexiglass.

REFERENCES

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