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The effect of temperature on the mechanical properties of ZnO material: the calculation of generated electrical energy from ZnO nanowires

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Abstract:

This work report on the calculations of the temperature dependence of young's modulus, dielectric, piezoelectric and elastic coefficients, poisson ratio and moment of inertia. These parameters are key parameters in the calculation of electrical energy generated from bending of ZnO nanowires (NW's) of length and width equals to 600nm and 50nm respectively due to applying an external force in one direction by an AFM tip (Atomic force microscopy) in the limits of elasticity. Results show that the young's modulus and dielectric coefficient show indirect proportionality with temperature while other parameters shows direct proportionality. These parameters having profound effect on the amount of the maximum generated voltage. The effect of the dependence of young modulus on temperature on the harvested electrical energy from ZnO nanowire formed on a substrate is minor.

Key Words: Nanowires , ZnO Nws , Electrical energy generation

1- Introduction

Smart structures based on piezoelectric materials are now finding applications in a wide variety of environmental conditions. In general, in applications, these materials or structures work at room temperatures or on a relatively narrow temperatures interval around the ambient. But there are also many applications where they have to work at temperatures above or below the ambient. Therefore, it becomes compulsory to know the behavior of their main parameters with temperature in order to make the proper design for any specific application.

However, in many applications, a transducer (or nanowire generator) having material properties and in order to predict the transducer response as a function of