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Modeling of Schottky diode characteristic by machine learning techniques based on experimental data with wide temperature range

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ABSTRACT

In this study, 4 common machine learning methods have been used to model the I–V characteristic of the Au/Ni/n-GaN/undoped GaN Schottky diode. The current values of previously produced Au/Ni/n-GaN/undoped GaN Schottky diode against the voltages applied to the diode terminal starting from the temperature of 40K up to 400K with 20K steps were measured. Models were created using Adaptive Neuro Fuzzy System, Artificial Neural Network, Support Vector Regression, and Gaussian Process Regression techniques using experimental data containing 5192 samples in total. After determining the combinations and specifications for each one that provide the lowest model error of each model, the performances of the obtained models were compared with each other concerning the various performance indices. The performance of the ANFIS model was found to be much better than the others in both the learning and test phases with RMSE model errors as 6.231e-06 and 6.806e-06, respectively. Therefore, it was proposed as a powerful tool for modeling I–V characteristics at all temperature values between 40K and 400K.

1. Introduction

Schottky diode is a metal-semiconductor rectifier contact diode [1]. Metal-semiconductor Schottky diodes are very important from a technological point of view. Schottky diodes, which have very fast switching capability and can operate at low forward voltages, have gained an important place in electronic technology [2,3]. Schottky rectifier contacts, which are formed by the tight contact of semiconductor and metal, are rapidly becoming widespread in semiconductor technology due to their fast transition to conduction and their ability to operate at high frequencies.

Many devices consisting of direct bandgap III-nitrides and their alloys have applications and have gained an important place in technology. Such devices can be examined in two categories as electronic and optoelectronic devices. Laser diodes (LDs), light-emitting diodes (LEDs), UV Schottky barrier (SB) photodetectors, and III-nitrides are particularly advantageous in high power and high-speed electronic applications due to their high-speed electron mobility and high breakdown field [4–8].

It is necessary to examine the electrical properties of devices obtained from GaN and III-nitride semiconductors under different temperature conditions. It is very important to determine the basic parameters such as Schottky barrier height, ideality factor, and series resistance obtained from the current-voltage properties of metal-semiconductor Schottky structures obtained at room

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