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An experimental study on determination of the shottky diode current-voltage characteristic depending on temperature with artificial neural network

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ABSTRACT

Shottky diodes are one of the important components of electronic systems. Therefore, it is very important to determine the parameters of the diodes according to the area in which they will be used. One of the most important of these parameters is the current-voltage characteristic of the diode. In this study, firstly, current values of the Schottky diode in the voltage range of −2 V to +3 V are experimentally measured in the temperature range of 100–300 K. In order to estimate the current-voltage characteristic of Shottky diode at different temperatures, a multi-layer perceptron, a feed-forward back-propagation artificial neural network was developed using 362 experimental data obtained. In the artificial neural network where temperature (T) and voltage (V) values are selected as input variables and the hidden layer has 15 neurons, the current (I) value is obtained as output. The results obtained from the artificial neural network have been found to be in good agreement with the experimental data of the Schottky diode.

1. Introduction

Metal-semiconductor contacts have an important place in the technology of semiconductor devices. Today, they are indispensable elements of many high-tech products [1,2]. One of the important factors that determine the electrical properties of these contacts is the electronic properties of the semiconductor [3]. At this point, Silicon carbide (SiC) is an interesting material due to its electrical properties such as wide bandwidth, high thermal conductivity, and critical breakdown electric field [4–7]. On the other hand, it plays a role in making electronic materials that require high magnetic fields and can withstand high voltage or high power, high temperature, and high frequency, where many circuit elements are forced [8–10]. It is also used in applications such as laser diodes due to its low dielectric constant [11]. Apart from these, metal-oxide semiconductor diode is used in semiconductor transistor construction, field-effect transistor construction, and hydrogen sensor construction [12–14]. Many researches have been carried out to determine the electronic properties of these structures, which are used in such a wide area. In particular, some of the most important parameters of these structures, such as barrier height, ideality factor and resistance, are determined by the method of current-voltage characteristics. Therefore, in metal-semiconductor contacts, current and voltage are interconnected by a kind of correlation. To understand this correlation, artificial neural networks (ANN) have been used recently. Artifical neural networks detect the relationship between data patterns, collect their information and learn (or are trained) by experience, not by programming [15,16]. It basically consists of three basic layers. Input neurons layer gets data from input files or directly from electronic sensors in real-time applications. The output layer sends information directly to the outside world, secondary computer operation, or other devices such as a mechanical control system. The hidden layer between these two layers contains most of the neurons in various interconnected structures. The inputs and outputs of each of these hidden neurons only go to other neurons [17].

Chen et al. [18], in their study, the surface and interface properties of Pd0·9Cr0.1/SiC Schottky diode gas sensors both before and after annealing Auger electron spectroscopy (AES), scanning electron microscopy (SEM) and energy dispersion spectroscopy (EDS) they

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