

As based on the adsorption of the gas

[Design](#), [Architecture](#)



As environmental regulation become more stringent, the need to develop highly sensitive gas sensor grows. To meet the demand of low level gas detection, gas sensors should be upgraded in sensitivity, selectivity, and speed of response¹. At the same time they should be cost effective and reliable over long term². Metal oxide semiconductor sensors based on electric conductivity measurement have been used extensively for gas detection. SnO₂ is most widely used material among semi-conductor oxide for making sensors due to its low cost, long life and good reproducibility^{3, 4}, thick film SnO₂ device are most studied and most candidate due to their high level of sensitivity, simple design, low weight and cost effectiveness. SnO₂ is an n-type, wide-band gap (3.6 eV) semiconductor⁵. Its electrical conductivity is due to the non-stoichiometric compositions as a result of oxygen deficiency⁶.

The sensing properties of the thick film gas sensor are based on the adsorption of the gas molecules on its surface which produce changes in its conductivity⁷. When exposed to air, freshly prepared tin-oxide particles adsorb oxygen atoms on the surface⁸. These oxygen atoms pick up electrons from the conduction band of tin oxide and are adsorbed on the particle surface as O⁻ ions. Each tin oxide particle is covered with negatively charged O⁻ ions on the surface. On the other hand, due to depletion electrons, there exists a layer of positively charged donor atoms just below the particle surface. The O⁻ adsorbents react with the gases and release the electrons to the conduction band at higher temperature, when reducing gases come in contact with sensor. Consequently, the depth of the space-charge layer decreases, which results in a decrease in the height of

the potential barrier for the electronic conduction at the grain boundaries. The concept of ANN analysis have been discovered nearly 50 years ago, but in handling the practical problem it is used only from last 2 -decades⁹.

ANN are collections of small individually interconnected processing units. Information is passed between these units along interconnections. An incoming connection has two value associated with it, an input value and a weight. The output of the unit is a function of the summed value. Once an ANN is trained for a prescribed data it may be ready to be used then for the prediction or classification ANNs can automatically learn to recognize pattern in the data real system or from physical models, or other sources. An ANN can handle many input and produce answer that are in a form suitable for designers¹⁰. Artificial Neural Network (ANN) model may be used as alternative method for technological analysis and matlab based calculation.

Artificial Neural Networks have two main components-the processing element called neurons and the connection between them, each connection have their own weights. The neurons are the information processors and the connection functions are the information storage. Each processing element first calculates a weighted sum of the input signals and then applies the transfer functions .

The term ' Feed Propagation' comes due to the training method used during the training process-back propagation of error. A Gradient Descent Backpropagation with adaptive learning rate algorithm is used to adjust the weights in the hidden and output layer nodes. The result is a network that produces the mapping between the input values and output values with

help of the neurons. In this model perception, Feed-Forward Propagation is one of the suitable methods of artificial neural network, designed for the testing and training of data. Three training methodologies based upon forward propagation were used.

Pure linear, logarithmic and tangent network transfer function for all the neurons, which reflects the relationship between concentration as input and sensitivity for different concentrations as output of SnO₂ based 1%Pd-doped thick film gas sensor. Sensitivity is tested by artificial neural network. In neural network architecture one layer acts as input layer, ten neurons act as the hidden layer and other layer output layer. In this model input is concentration of methanol and output is the sensitivity of sensor. Though in present work single sensor is exposed to single gas or vapor at a time and ANN is utilized to confirm it with experiments so that the data collected can be used to train the network when sensor is replaced by sensor array and single gas is replaced by group of gases or vapors to achieve high selectivity. This model was trained to generate a mapping between the input concentration of the methanol and output as the sensitivity of the methanol. Sensitivity is dimensionless quantity which is obvious from its expression. In the present work for reorganization of the sensitivity of the 1 %Pd-doped SnO₂ sensor feed forward network has been used. A Feed Forward network can be used for the reorganization of the pattern of the system.

Feed Forward network uses the Gaussian activation function. The importance of such function is that it is non negative for all values of x .