Presented at NDE2002, to predict. assure. improve. www.nde2002.org
National Seminar of ISNT, the Indian Society for Non Destructive Testing
Hotel Taj Connemara and Raja Mutiah, Chennai, India, 05. – 07. 12. 2002

Multilayered Perceptron Based Artificial Neural Network for Prediction of Temperature Generated During Tensile Deformation

C. Rajagopalan, B. Venkataraman, T. Jayakumar, P. Kalyanasundaram and Baldev Raj

Materials Chemical and Reprocessing Group
Indira Gandhi Centre for Atomic Research
Kalpakkam - 603 102

Abstract

It is well known that during tensile testing, a part of the mechanical work done on the specimen is transformed into heat energy. The ultimate temperature rise and the rate of temperature rise is related to nature of the material, conditions of the test and also to the deformation behaviour of the material during loading. Using infrared imaging it is possible to detect the variation of temperature and consequently predict the deformation behaviour of the material. Thus, infrared imaging can be viewed as an adjunct to conventional mechanical test techniques. Apart from the basic advantage of non contact temperature determination, the technique offers itself to the detection of transient exothermic or endothermic changes that cannot be normally observed through conventional mechanical testing practices. At the author's laboratory, infra-red (IR) imaging has been successfully used to characterise the various stages of tensile deformation of a nuclear grade AISI type 316 stainless steel.

In the field of NDE, ANNs have been used for the analysis and classification of defects detected by ultrasonic, acoustic emission and eddy current testing. However, in the field of thermal imaging the reported applications of ANN are few. ANNs have been primarily used for defect *detection and classification.* In the present work, we explore the feasibility of using multi-layered, error-back-propagating, feed-forward artificial neural network (MLP-ANN) for *predicting* the temperature during tensile deformation of nuclear grade AISI Type 316 Stainless Steel.

The parameters used in this study are (a) stress, (b) nominal strain, (c) maximum temperatures and (d) strain rates corresponding to cross head speeds of velocity 1 mm/min, 2 mm/min, 5 mm/min, 10 mm/min, 20 mm/min and 50 mm/min. . The MLP-ANN is trained to predict the temperature, while feeding the other three parameters as inputs. For the following neural network prediction study, the DESKPACK Software System (DSS) was used. A total of 204 data vectors were used for predicting the temperature values. The data vectors, being values from different physical quantities, were having wide ranging values. In order to use these values in an MLP-ANN effectively, these were mapped onto a scale between 0.1 and 0.9, so as to increase the efficiency of the MLP-ANN. While mapping these values, the scaling factors were saved, so that a reverse mapping could be done later to compare the original (temperature) values with the predicted values. The study clearly revealed the feasibility of using MLP-ANN for predicting the temperature with errors of the order of 0.5% during tensile deformation of nuclear grade AISI Type 316 SS.