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Prediction of mechanical strength of magnesium alloy AZ31 with calcium addition using a neural network based model

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Abstract. The aim of the research is to develop a neural network model to predict the mechanical strength of AZ31 magnesium alloy in addition with Calcium. This would help researchers or academicians to fabricate the magnesium alloy AZ31+x wt. % Ca which finds more importance in making biodegradable implants in orthopedic surgery. As the yield strength of human bone lies between 104.9 – 114.3 MPa whereas for pure Mg it is very lesser, it is needed to make alloys suitable for biomedical applications which are to be satisfied with their mechanical properties and biocompatibility. An artificial neural network-based model is used to predict the mechanical properties of Mg alloys AZ31+x wt. % Ca with compositions of Al, Zn, Mn and Ca as countable parts with various proportions. The compositions and properties of twenty different as cast alloys were used for training and prediction of the desired mechanical properties using Artificial Neural Network and the outputs are compared with the experimental results. The results show that the Levenberg-Marquardt (LM) algorithm serves better in prediction of mechanical properties of Mg alloys AZ31 and AZ31+1 wt. % Ca. Also the results were found significant at 90%, 95% and 99% confidence limits.

1. Introduction

Prediction of properties of metal alloys and composites using artificial neural networks before finding their properties experimentally becomes necessary to decide the composition of materials to be taken in account to achieve the desired results. The predictions reduce the time and cost of the researchers before fabricating and testing of the materials. Though many prediction methods give only approximate values against the exact one, it would be possible to predict the level of accuracy of the outputs saving the time for the researchers, academicians and scientists [1]. Magnesium finds its remarkable applications in automotive, naval, aerospace and even in biomedical applications with its density lesser than Aluminium [2-6].

This research is focused on prediction of mechanical properties (Yield strength) of Mg alloys that are adoptable for biomedical applications after adding Aluminum, Zinc and Calcium. The alloys prove its