

EXPERIMENTAL INVESTIGATION FOR PERFORMANCE ENHANCEMENT OF WIRE ELECTROCHEMICAL MACHINING (WECM) DURING MICROMACHINING OF SHAPE MEMORY ALLOY

Abstract

Wire electrochemical machining (WECM) is a promising method for the fabrication of high aspect ratio complex microfeatures. In this research work, experimental investigation for performance enhancement of WECM during micromachining of nitinol shape memory alloy (SMA) has been conducted by developing novel experimental setups and planning with advanced industrial applications in the fabrication of microfeatures. Hence, corresponding to specific development stage, axial flow system, vibration system and nozzle jet system has been used for the flushing. The performance enhancement in WECM has been carried out by comparing vibration-assisted axial nozzle jet flow system with other flushing methods. Also, the investigation has been carried out for the effect of nozzle diameter and workpiece nozzle stand-off distance on slit width and accuracy.

Further, it incorporates the experimental investigations carried out for the reduction of overcut and stray current attack using different wire coating and insulation methods during WECM. The effect of novel PTFE tube insulation coating and synthetic enamel coating have been studied during WECM considering exposed wire angle and distance of coating from the upper surface of the workpiece.

This research work deals with the effect of different aqueous neutral electrolytes, mixed neutral electrolytes and mixed ozonated electrolytes in addition with EDTA as complexing agents. Also, the electrochemical impedance spectroscopy (EIS) and potentiodynamic electrochemistry (PDE) tests for polarization behaviour of nitinol SMA have been conducted for electrochemical characterization.

It also overviews the experimentation carried out for investigating the effect of most of the prominent process parameters for micromachining of nitinol shape memory alloy during WECM. It includes in-depth study of dissolution behaviour of nitinol SMA in 0.1 M H_2SO_4 acidic electrolyte solution and characterization of nitinol SMA before and after machining. It also incorporates the effect of energy input parameters on wire feed rate and finally complex curved microfeatures of nitinol shape memory alloy has been fabricated.

Hence, the study presented in this research work through the in-depth experimental investigations of nitinol SMA may be useful for effective utilization of WECM process for various practical engineering applications.

Keywords: Wire Electrochemical Machining, WECM, Nitinol SMA, Shape Memory Alloy, Micromachining