Materials Today: Proceedings 43 (2021) 183–190

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Optimization of WEDM parameters on surface integrity characteristics of NiTi shape memory alloy

J. Kesavan [a,*], C. Velmurugan [b], V. Senthilkumar [c], S. Dinesh [c]

[a] Department of Mechanical Engineering, Periyar Maniammai Institute of Science and Technology, Tanjore, Tamil Nadu 613403, India
[b] Department of Mechanical Engineering, Indian Institute of Information Technology, Tiruchirappalli, Tamil Nadu 620015, India
[c] Department of Production Engineering, National Institute of Technology, Tiruchirappalli, Tamil Nadu 620015, India

ARTICLE INFO

Article history:
Received 30 June 2020
Received in revised form 15 October 2020
Accepted 19 November 2020
Available online 10 January 2021

Keywords:
NiTi
Shape memory alloy
Wire electrical discharge machining
Surface integrity characteristics
Optimization

ABSTRACT

The extensively adopted non-traditional approach of wire electrical discharge machining (WEDM) process can be formulated the complicated shapes and difficult-to-cut products with cost effective solution. The surface integrities and mechanical characteristics are sternly affected in the nickel titanium shape memory alloy (*NiTi* SMA) during WEDM process. In this study, an attempt has been made to investigate the effects of machining parameters on the surface integrity characteristics of *NiTi* SMA. The machining parameters such as servo voltage, input power, wire speed, pulse-on and pulse-off time were considered as inputs and their effects on surface integrity characteristics such as surface roughness, material removal rate, microstructure and hardness were studied. The machining process has been carried out with three levels of input parameters in the full factorial design. The TOPSIS analysis was used to evaluate the optimum machining parameters in order to exhibit the better surface integrity characteristics for *NiTi* alloy. The results of the optimization technique revealed that the better surface integrity properties (minimizing the roughness and maximizing the material removal rate) were achieved with the combination of 3 A input power, 9 μs pulse on time, 8 μs pulse off time, 20 V servo voltage and 3 m/min wire speed.

Selection and peer-review under responsibility of the scientific committee of the 1st International Conference on Energy, Material Sciences and Mechanical Engineering.

1. Introduction

The versatile applications of NiTi SMAs in different fields specifically biomedical (stents, vena cava filter), aerospace (flexures, flap edge) and robotics (micro-grippers, actuators), it is required to machine to develop the complicated shapes. Moreover, SMAs find applications in servo motors, actuators, thermo-mechanical sensors, bone, vascular implantation, sealing, and coupling [1,2]. Hence, high precision is required in the development of smart materials with an intricate shape. Generally, three types of SMAs are used in industrial field such as nickel-titanium alloys, copper-zinc-aluminium-nickel and copper–aluminium–nickel. Among these, the most prevalent SMA is NiTi based alloy which exhibits high damping capacities, good biocompatibility, shape memory effects and pseudoelasticity along with corrosion resistance and fatigue strength [3–7]. NiTi SMAs are processed by the conventional and unconventional methods of machining to shape the required products as per the dimensions. The conventional machining of NiTi SMA is complicated due to its distinctive features such as pseudoelasticity, shape memory effect, high toughness, rapid tool wear, high chemical reaction, low thermal conductivity, high hardness and high strain hardening [8,9]. In order to avoid such problems in the conventional methods, special machining of non-traditional methods such as WEDM, EDM and laser machining are used in the machining of NiTi SMAs [10,11].

Habib et al. [12] machined the intricate shape and texture profile on smart materials using WEDM process. It is ensured that the WEDM is one of meticulousness non-traditional machining process for preparing such kind of functional materials as per the requirements. The investigation on the machinability characteristics and shape recoverability of NiTi alloys exhibited using WEDM process with the variation of input parameters such as flushing pressure, servo voltage, input power, electrode material, peak current, short pulse time, wire feed and pulse-on, off time. The machinability characteristics during WEDM process can be evaluated by electrode wear rate (EWR), material removal rate (MRR) and surface roughness of the machined area. Productivity of such kind of smart

* Corresponding author.
E-mail address: jothikesavan2284@gmail.com (J. Kesavan).

https://doi.org/10.1016/j.matpr.2020.11.616
2214-7853/
Selection and peer-review under responsibility of the scientific committee of the 1st International Conference on Energy, Material Sciences and Mechanical Engineering.