ENHANCEMENT OF MICRO-DRILLING PERFORMANCE BY CRYOGENIC TREATMENT OF DRILL BIT

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KEYWORDS

Micro-drilling, Cryo-treatment, circularity, Grey-Taguchi Method

INTRODUCTION

Cryogenic treatment is one time permanent treatment that affects the entire section or bulk of the component unlike coatings. The cryogenic treatment is an add on process over conventional heat treatment in which the samples are cooled down to prescribed cryogenic temperature for a long time and then heated back to room temperature. The process is not a substitute for heat treatment but rather an extension of the heating/quenching/tempering cycle. In most instances the cryogenic cycle is followed by a heat tempering procedure[1]. Two major changes in micro-structure of steel occur as a result of cryogenic treatment[2,3], which play the principal role for dramatic improvement in wear resistance. The retained austenite are transformed to wear resistant martensite to achieve more uniform hardness. Fine carbide precipitates are formed during the long cryogenic soak. These fine particles along with large particles form a denser, more coherent and much tougher matrix in the material. Yun et al.[4] verified the changes in the microstructure of M2 high speed steel when the materials was submitted to different cycles of cryogenic treatment at -196 degree Celsius. Dong et al.[5] investigated in detail an effect of varying the deep freezing and tempering cycles on high speed steels and concluded that improvement of wear resistance in tool steels because of elimination of retained austenite and initiation of nucleation site for precipitation for large number of very fine carbide particles. Empirical investigations have demonstrated that the tool life of cutting tools like high speed steel and tungsten carbide can be enhanced by cryogenic treatment[6].

In the present investigation the micro-drilling of titanium alloys have been carried out using cryo-treated H.S.S. micro drill bit of 500micron and 1mm diameter. Experimental investigations have been carried out using Taguchi L9 orthogonal array The micro drill bits are cryo-treated and tempered after cryo-treatment. The drilling torque and thrust was measured using piezo-electric mini dynamometer. The circularity and burr-size of micro holes are measured using scanning electron microscope. The grey Taguchi method is adopted to optimize the multi objective criteria.

EXPERIMENTAL INVESTIGATION

The micro-drilling operation has been carried out in multipurpose micro-machine DT110 and CNC milling machine. The drilling torque and thrust were measured using a piezo-electric mini-dynamometer. The circularity error and burr size are measured using scanning electron microscope and optical microscope with image processing software. The micro holes are drilled with cryo treated tools. The input parameter are cutting velocity , feed and step feed. The micro drilling performance are observed with different step feed with other fixed parameters. It is proposed to compare the micro drilling operation using cryo-treated tools with untreated tools. Micro-drilling operations have been carried out with cryo-treated tools with and without tempering. The cryo-treatment has been carried out in a cryo-box with provision automatic temperature controller.

CONCLUSION

The performance of micro-drilling for machining titanium alloy using cryo treated HSS micro-drill bits have been investigated. The optimisation of the process has been carried out using grey Taguchi method for a multi-objective criteria to minimise circularity error, burr size, machining time, drilling torque and thrust.

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