Discussion on Thin WEDM Error Analysis and Characterisation

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Introduction

The present paper presents the current research that is being conducted by the Department of Micro & Nanotechnologies of Tekniker and the Department of Mechanics of the Engineering University of Bilbao in order to characterise the machining errors that appear in the machining of precision miniaturised parts by thinwire electro discharge machining (WEDM).

The analysis of previously machined parts has shown that the real error presents an important scattering that depends on many aspects, specially on the type of wire, the wire tension, etc.

Finally, the maximum part height that can be machined by thin WEDM in different materials is very important in order to establish the maximum dimensions of the components that can be processed by this technology.

Conditions and Objectives

The test have been performed in the machine available at the Micro and Nanotechnologies Dep.
Of Tekniker:Sodick AP200L.
The dielectric fluid used for the thin WEDM process was Iono Plus 3000 from OelHeld (the application of oil as cutting fluid can reduce the gap and reduce the unit removal rate of the EDM (process).
The thin WEDM process depends as much on the machine as it depends on the auxiliary tools like the contact pieces, the guides or specially, the used wire electrode.
Most of the mentioned components are currently provided by the machine tool manufacturers, being the field of selection reduced to a narrow range of products.
The thin wire electrode is provided by a limited number of manufacturers.

Description of the Tests

The tests have been performed by Tekniker with
the support of the Engineering University of Bilbao. The University has performed a important research in the field of conventional sinking EDM and WEDM.
The approach to the analysis of the thin WEDM process has taken benefit from the experience of the partners in order to define the testing procedure.
The procedure defined by the Engineering University of Bilbao in previous projects[4] has been applied to this study trying to suit all parts and facilities to the thin WEDM process.
The concepts and variables fixed at the beginning of the study are presented in the next lines.

Description of the Tests

In order to force the machine to interpolate two axes in the direction change and fine the effect of the wire lag, A 0.050 mm radius round was applied at the corner to force the machine to interpolate the axes during the direction change (fig.1).

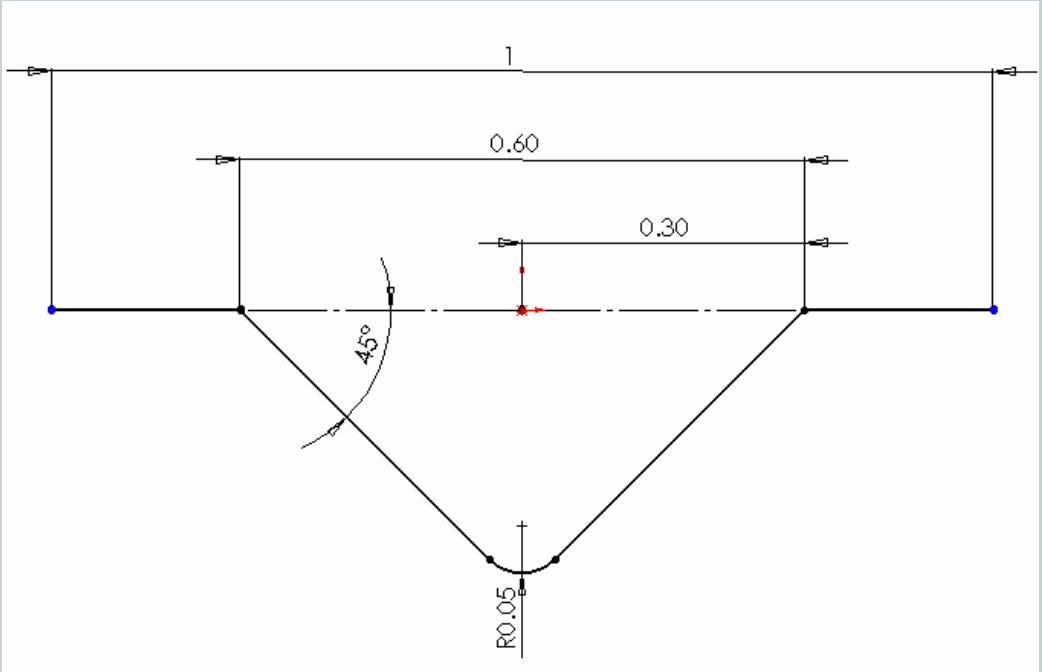

Fig. 1. Programmed Path.

Description of the Tests

Concerning the part characterisation, it should be considered when designing the test parts.
The measurement of small components is nowadays an important topic of research (micrometrology) that has found many problems. Knowing this difficulty, the possible characterising equipment was analysed in order to state if the part could be measured conveniently.

Description of the Tests

The part dimensions were adjusted to the measuring area of the white-light confocal microscope available at the facilities of Tekniker (693.50 x 509.18 μm).

The stitching phenomena presents some errors in the joining area and they were avoided.

In order to analyse the process repeatability,four cuts were performed per part (fig. 2)

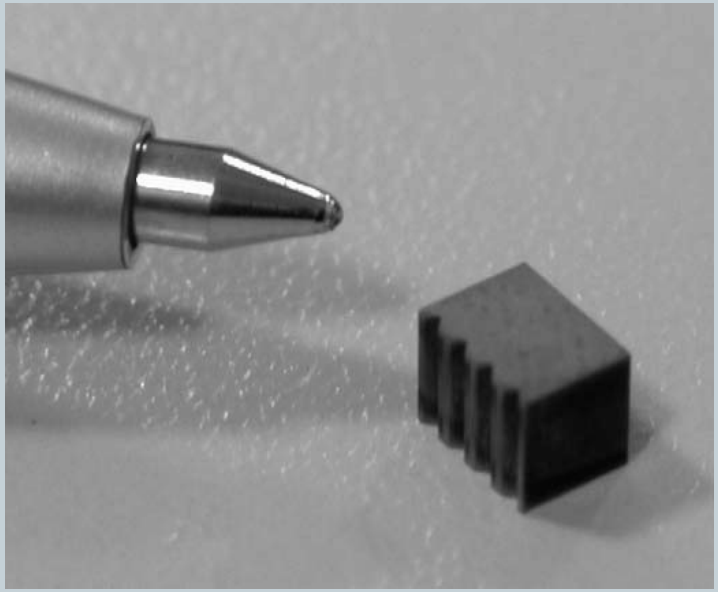

Fig. 2. WC test parts

Description of the Tests

Wire Tension and Process Parameters

The wire tension in WEDM process is a key variable with big influence on the part precision and the process stability.
In thin WEDM,the importance is even higher,wire breakage can appear with reduced tension fluctuations but,on the other side,bigger tension values should provide higher precision.

Description of the Tests

The Sodick AP200L does not use a tension control system for Ø0.030 mm wire but a system of counterweights whose mass adjusts the tension acting on the wire.
Apart from these masses, the wire tension depends on the friction in the different pulleys and contact parts.
The counterweights applied for the cutting processes were 0,12,20and30 grams.
Finally, the cutting conditions applied in the first tests were fixed according to the experience of the operators.

Analysis of the Results

Several parts have been cut applying different wire tension values (0,12,20and30grams).
These parts have been useful to identify the previously mentioned problems of part characterisation, optimise the mat lab routine for data analysis and establish the bases for a more in-deep study that should be supported by more data in order to achieve clear conclusions.

Analysis of the Results

As it could be expected from the experience in normal WEDM and the reduced dimensions of the test parts, when no counterweight is disposed the wire vibration becomes important after changing the cutting direction and it does not achieve the stable position as it gets out of the part.
Applying more mass, the wire tension is increased and the error decreases.

In all cases, the corner radius that is fitted by least squares presents deviations of +5~+10 μ m.
But the fitting presents an important standard deviation, not presenting important differences if a different radius is considered for the calculation of the machining errors.