RAPID TOOLING FOR EDM ELECTRODE: A REVIEW

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ABSTRACT

Various techniques and methodologies developed by number of researchers to fabricate EDM electrodes from these sub-categories are discussed in this paper. From the literature survey it is concluded that there is a great scope for Rapid Tooling to compete with conventional electrode manufacturing techniques but there is a need to develop a proper rapid manufacturing system rather than a prototyping system because still, no rapid prototyped EDM electrode have achieved industrial grade quality. This paper gives a review of various Rapid Tooling attempts made to develop EDM electrode through different RP process and their performance results. Basically the fabrication of EDM electrode has been classified into three sub-categories i.e. Non-Conductive RP model, Conductive RP model and RP model for casting electrodes.

Keywords: Rapid prototyping; additive manufacturing; EDM; CAD

1. INTRODUCTION

Rapid prototyping (RP) is a layer additive manufacturing process where in 3D working model is directly manufactured from a CAD model [13]. Over the last two decades the technology to produce part directly from 3D CAD model drawings have evolved immensely, various new techniques with new materials have been introduced for rapid prototyping and modelling to use those models in different applications. The models produced were generally used as prototypes only to analyse the designed model and its working but nowadays work is going on to take the developed models one step further and use them as a tool for manufacturing processes, this is also termed as Rapid tooling [9]. Non-traditional machining operations are potential applicants that can make use of the benefits of rapid tooling technology [32].

The quality of model developed by Rapid prototype technique defines the final use of that model. Model building parameters like surface roughness, dimensional accuracy, material used, and post process used for finishing, controls the quality of model. The RP techniques generally used in industry nowadays are SLA wherein polymer resin is hardened by laser beam, this technique produces most accurate plastic models compared to other techniques. Solid Ground Curing (SGC) is another technique in which entire layer of part, made of photo curable resin is hardened in a single stage with UV rays. Hence it is faster process compare to SLA. Fused Deposition Modelling (FDM) is one of the cheapest RP process with average accuracy, in which thermoplastic filament is solidified layer by layer to form the part (Fig. 1). Selective Laser Sintering (SLS) is another RP technique in which Nano sized powder are bonded together with the help of a high power laser beam [34].

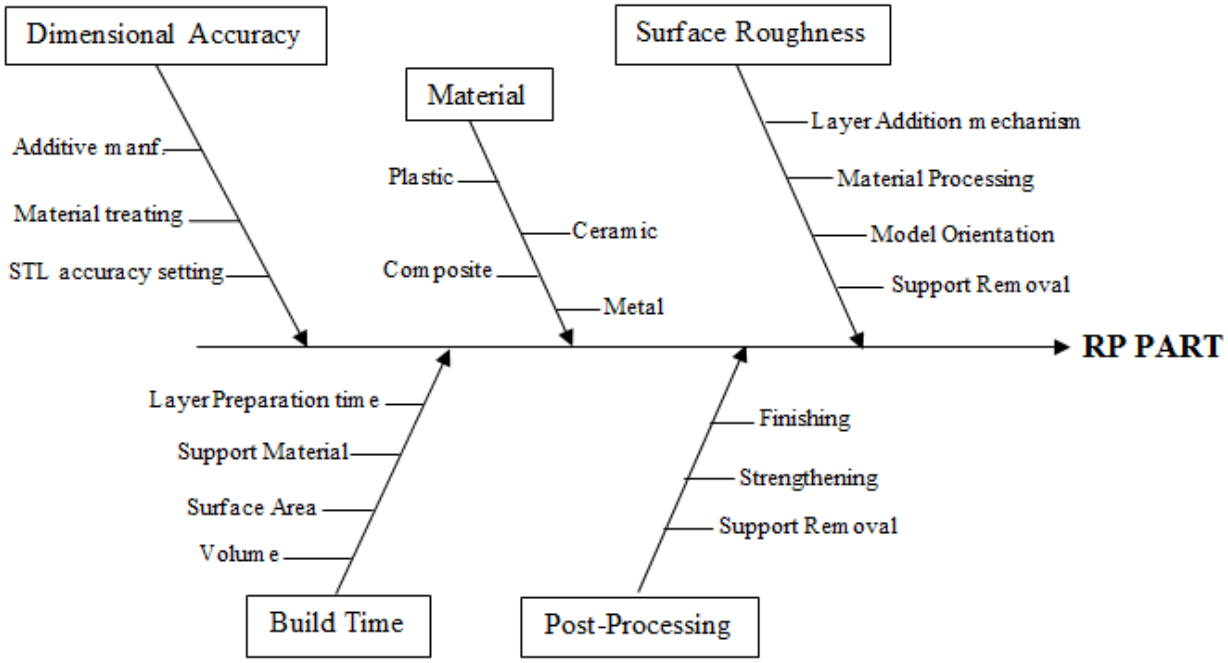

Figure 1: Factors affecting RP Model

1.2 EDM Factors

The material removal rate is dependent on spark timing of each cutting cycle. Longer the spark generation will be, greater will be the speed of material removal from the surface of the part. Longer spark generation results into deeper and wider craters formation on the surface of the machined parts. So for fine surface finishes one needs to reduce the spark ON time [12]. The delay required by the dielectric medium to re-ionise for the spark generation is a necessity in EDM process which is signified by the pulse OFF time. Shorter the OFF time will be for the dielectric medium greater will be the speed of machining. Although longer pulse OFF time reduces the speed of machining but it also provides stability [21].

Current in EDM process is the measure of power used in the machining. For any EDM machine whether die sinking or wire EDM, the amount of current used in process depends upon the surface area of the electrode in contact to the job. For the roughing cuts and large surface area machining operations we use high current input. The spark gap between electrode and job is determined by the current amperes and the duration of pulse ON time [7]. To reduce the problem of large crater development at high currents, the electrode fabricated is undersized so that sufficient room is left for finishing cuts to remove the final piece of metal. Polarity in EDM machine signifies the charge of the electrode in machining operation where positive polarity is for negatively charged electrode and vice versa [26].

2. RAPID TOOLING EDM ELECTRODE

The electrodes developed by rapid prototyping has to be of high accuracy and very good surface finish, to change the conventional methods of developing EDM electrode. In order to achieve these quality factors in RT electrodes, one has to follow some post processing steps after developing prototype of electrode from RP machine. The methods to develop RT electrode can be categorized according to the property of material of RP pattern i.e. if RP model is electrically conductive, non- conductive or could be used as pattern for casting mould.

Prior to completely developing EDM electrode some post-processing operation after making RP pattern has to be followed, For non- conductive model, metallization process like electroforming, metal spraying etc.

2.1 Non-Conductive RP Electrodes

Hsu et al. [14] 2007 examined an actual method for developing electrical discharge machining (EDM) electrodes by means of the RP system grounded on electroless plating. Method discussed was revealed for surface development of EDM electrode. The electrode pattern was strained with Pro/E 3D CAD, then the CAD exemplary was converted into the stereo-lithography (STL.) file format. Rapid prototyping machine (Zcorp 402 3DP) was implemented to create a gypsum powder electrode model with a multifaceted exterior. The gypsum solid was wrapped by resin infusion, improving its water confrontation and strength. Electroless plating was formerly executed to present electrical conductivity into the gypsum electrode exterior, tailed by copper electroforming of the thickness around 1 mm to get the EDM electrode. Additionally, die-sinking electrical discharge machining was executed on SKD11 mold steel material by varying EDM parameters for different electrodes. From the experimental results it was concluded that process defined above is feasible for manufacturing of EDM electrodes.

2.2 Conductive RP Electrode

Xu et al. [30] 2015 proposed research work to develop 3D micro electrodes from Laminated Object Manufacturing (LOM) rapid prototype process, to EDM micro cavities in the workpiece. The experimental study began with the fabrication of 3D queue electrode from 100μm thick layers of copper foil, each layer of copper was wire cut with the help of WEDM (model H: CUT32F) manufactured by HI-LINK precision machinery corporation. The number of copper foils else Multi-layers were then bonded together with vacuum furnace manufactured by Shenzhen Zhongda Electric Furnace Factory. German Physik Instrumente High-precision motion platform was used to set up the micro-EDM experimental platform. Furthermore, surface roughness of micro-electrode generating 3D cavity was measured by laser confocal microscope made by japan KEYENCE.

3. CONCLUSIONS

Over the years many attempts have been made to use Rapid prototyping as an alternative to CNC machining to directly fabricate electrodes from CAD model for Electric Discharge Machining of hard to machine material. The electrodes have been developed for application in rough, Semi-rough and finishing applications. The possibilities of printing any complex shape in RP has opened new gates for EDM electrodes leaving conventional CNC milling operation far behind, this possibility have attracted many researchers over the years and they have established new benchmarks in manufacturing technology.

There are various RP technology in the market with each having its own advantages and limitations but all the RP process have one problem in common with respect to EDM application i.e. stair stepping generation on the part which is created due to the layer thickness in the respective RP process. The quality of the part produced is also controlled by the support system used in fabrication of part in RP systems like LOM, FDM and SLA with most accurate parts produced by SLA and least by FDM. None of the RP systems yet have the capabilities produce EDM electrode with an accuracy industrial requirement. Hence, methods needs to be developed to remove dimensional inaccuracy of the part. Methods like finishing process or milling to be used as

post-process can improve the quality of RP model to be used as EDM electrode in future. Hence, there is a scope for rapid tooling to be used for fabrication of EDM electrode.

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