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Research paper



An Introduction to Hybrid Machining Technology

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Abstract
Now recent research and development are focused on the combination of two or more machining method for difficult –to –machine materials, by which the limitations of one process can be resolved by another one and at the same time can take the benefits of other methods. Such kind of combination of machining process is called Hybrid Machining Processes (HMPs). This paper covers the different HMPs and their development.

Keywords: *Hybrid Machining Processes, cooperative HMP, collaborative HMP.*

1. Introduction

It is very difficult to machine a too hard and too tough material like tough super alloys, ceramics and composites also with a design needs like high precision, complicated geometry and high surface integrity and the machining costs pose complex challenges to manufacturing industry. If improvement can be done in the thermal, mechanical and chemical properties of these materials then it will be beneficial for the improved product performance. In some of the cases improved design makes the material difficult to machine efficiently and economically by existing machining method and unconventional machining method. Now recent research and development are focused on the combination of two or more machining method by which the limitation of one process can be resolved by another one and same time that can take the benefits of other methods. Such kind of combination of machining process is called as hybrid machining processes, by which better machining effect can be achieved like upgrade the metal removal rate, better surface finish.

2. Types of Hybrid Machining Processes:

Hybrid machining processes can be divided as two types–
1. Cooperative hybrid machining process
2. Collaborative hybrid machining process

2.1. Cooperative Hybrid Machining Process:

If all the processes are directly involved in the material removal mechanism it means that the material removal takes by the combined effect conducted by the processes. The cooperative HMPs are the combination of different mechanism that happens simultaneously during the machining process. The purpose of this is to introduce a new energy effect to remove the material like electrochemical discharge machining.

2.2. Collaborative Hybrid Machining Process:

Collaborative HMP means one of the processes is dominantly and directly involved in the material removal while the other either assists in the removal by improving the environment and conditions to enhance the machining by the main process. A typical collaborative HMP includes the machining process assisted by ultrasonic magnetic field, plasma and laser. There is various combination of the machining process for hybrid machining process that can be represented by the Fig.1 [1].

3. Recent Research and Developments in Hybrid Machining Processes:

3.1. Electro-Discharge and Electro-Chemical Cooperative HMP:

Researchers are still facing the problems with cutting or machining a difficult to machine materials which is non- conductive like ceramics, glass etc. and also increasing demand of processing these materials in industries and researchers are paying more attention on the hybrid machining processes. Recently research is going on a Electro Chemical Discharge Machining (ECDM) [2] in which electrochemical process is used to generate an isolating gas film between the tool and the electrolyte and then workpiece material which is near to the electrode is removed by thermal energy and probably same chemical/ electro-chemical etching effects [3]. This method has a great potential in machining a hard-nonconductive material. Research efforts are focused on improving the technique for the stability of gas film to achieve high performance ECDM of nonconductive micro-structures for the advancement of this technique these are various parameter like study about the influence of applied voltage on gas film quality disclosed that a stable electrochemical discharge machining can be obtained when the applied voltage exceeds the critical voltage and reaches a specific level. Apply rectangular voltage pulses that can improve the gas film stability and reduces the thermal damage,

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tendency of cracking and achieve high aspect ratio structure in micromachining [4].

3.2. Abrasive Assisted Wire EDM Cooperative HMP:

It is also another type of hybrid machining process which uses wire that is embedded with electrically non-conductive abrasives as the machine tool during wire electrode discharge process [5]. The nonconductive abrasive grains only assist the process by removing the debris out of the way. It leads to improves material removal rate.

3.3. Chemical Mechanical Polarization Cooperative HMPs:

It is a hybrid of chemical etching and free abrasive polishing. A process of removing surface material using chemical and mechanical means to achieve high planarity and high surface finish. The basic process is a wafer is held in the retaining ring of a wafer carrier, which rotates on the surface of a sponge-like pad. The pad rotates, abrading the wafer while simultaneously applying and

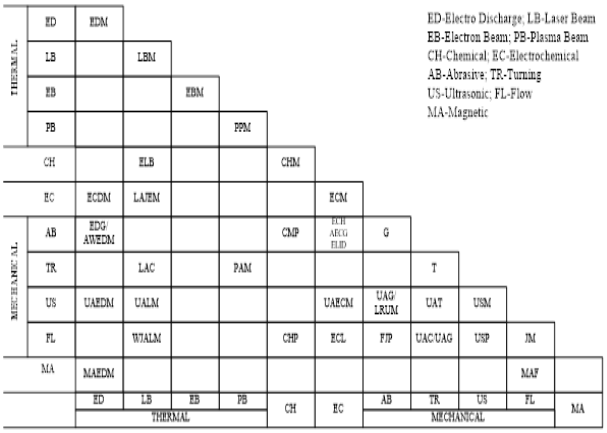


Fig. 1: Scheme for Combinations of various machining methods Torch

Replenishing the chemical slurry which enhances the mechanical abrasion. The process can be seen in the fig.3 [6].

3.4. Ultrasonic Assisted Electro Chemical Machining (ECM) Cooperative HMPs:

In this process, the ultrasonic vibrations are used along with ECM to achieve a very high-quality surface finish of the workpiece [7]. The vibration of the workpiece improves electrolyte flow at the inter-electrode gap. A tool attachment to the turning machine is to execute the ultrasonic electrochemical finishing and rolling leveling after the turning process. It has found that large electrolyte flow rate leads to a better finish. In a super finishing process researches have been conducted by using ultrasonic and magnetic assistance in electrochemical micromachining [8].

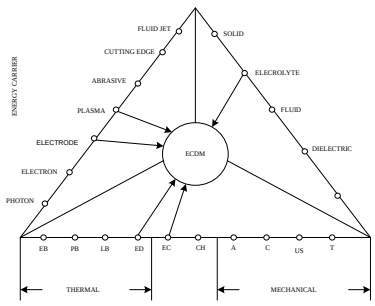


Fig. 2: Mechanism interaction of ECDM [1].

3.5. Laser Assisted Cutting Collaborative HMP:

This process takes the advantages of localized heating of the work piece for softening it by using laser beam, in front of the cutting tool. Generally, it offers lower cutting force, longer tool life, better machining surface. This method is used for hard material like ceramics [9, 10].

3.6. Magnetic Field Assisted EDM (MFAEDM):

In EDM, the magnetic forces facilitate the debris removal from the machining zone more easily and quickly. It has been found that in MFAEDM [11], high MRR, low TWR and better surface finish. Compare to standard EDM the hole depth 26% high can be achieved. compare to standard EDM.

3.7. Ultrasonic Assisted Grinding:

Ultrasonic vibrations are created on the workpiece during conventional grinding processes. It not only dramatically increases the Material Removal Rate (MRR) but also can reduce the surface damage during the machining. The surface roughness of 0.4 µm can be achieved by machining die steel with damage tool [13].

3.8. Ultrasonic Assisted Electro Discharge Machining (EDM):

The EDM process is commonly used in the tool and dies industry for mould making [1]. However, in recent year EDM has become an integral part of aerospace and electronics industries for making prototypes and production parts where production quantities remain low ultrasonic vibration movement of the workpiece would improve the slurry circulation the high frequency pumping action by pushing the debris away and sucking new fresh electric, stoutly ameliorates the discharge energization, increases their efficiency and given higher MRR and lower Tool Wear Rate (TWR).

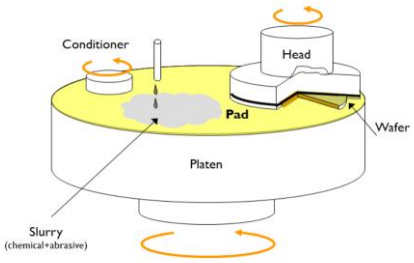


Fig. 3: Chemical mechanical polarization.

Ultrasonic vibration plays a crucial role in EDM such as direct constitution to the material removal and facilitating better machining condition for material removal. The ultrasonic vibration improves the liquid flow substantially and avoids the erosion product sedimentation. They found that the combination of high frequency vibration and rotation of electrode was more effective and gave the best results in comparison with pure EDM [16, 17].

3.9. Plasma Assisted Milling (PAM):

Plasma assisted milling is performed by applying an assisting plasma jet to the milling process. A study of PAM of three difficult to machine material indicate that the use of PAM for INCONEL 718 using whisker reinforced ceramic tools leads to an increase in tool life of approximately 200% but the machining of soft materials is not recommended because high temperature leads to a new metallurgical change with lower material properties. PAM is not suitable for precision machining processes because of dimensional vibration induced by thermal phenomena [14].

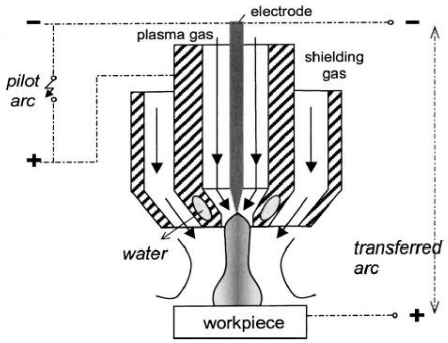


Fig. 4: Plasma Torch [14].

4. Conclusion

A single machining method is not very much capable to machine a difficult to machine materials with a complex shapes and size and also not capable to produce a super finished surface, micro holes, with very less tool wear. Hybrid machining for difficult to machine and hard and non-conductive materials can be machined easily. It is the full understanding of iterations between mechanisms and precise control of their influence to machining performance which will decide the avenues of future researches in this field.

References

[1] K.P. Rahurkar, Lin Gu, Recent research and developments in hybrid machining processes, All India Manufacturing Technology Design and Research Conference (AIMTDR) 24th, 2010, 39-44.
[2] V.K. Jain, Advanced Machining Processes, Allied Publishers Private Limited, New Delhi, 2002.
[3] R. Thanigaivelan, R.M. Arunachalam, Peldon Drukpa, Drilling of micro holes on copper using electromechanical micromachining, All India Manufacturing Technology Design and Research Conference (AIMTDR) 24th ,2010, 355-358.
[4] Subodh Kalia, V.K. Jain, V.N. Kulkarni, Febrication of micro features and micro tools using electro chemical micromachining, All India Manufacturing Design and Research Conference (AIMTDR) 24th, 2010, 315-319.
[5] Philip Koshy, Hamilton, Ian Menzies, Peterborough, Abrasion assisted wire electrical discharge machining process, United states patent application publication, 2010
[6] Joshu Chien, Chemical mechanical polarization, ME 107B Engineering Laboratory.
[7] P.S. Pa, Adv. Mater. Res., 2008, 44-46, 455-462.
[8] Jinka Ranganayakulu, Somashekhar S. Hiremath, Experimental investigation on electrochemical discharge machining and predictive modeling of material removal rate using adaptive Neuro fuzzy inference system, All India Manufacturing Technology Design and Research Conference (AIMTDR) 24th, 2010, 295-300.
[9] C. Nath, M. Rahman, S.S.K. Andrew, J. Mater. Process. Technol., 2007, 192-193,159-165.
[10] Z.W. Zhong, G. Lin, International Journal of Advanced Manufacturing Technology, 2006, 27, 1077-1081.
[11] G.W. Chang, B.H. Yan, R.T. Hsu., International Journal of Mechanical Tools and Manufacturing, 2002, 42, 575-583.
[12] W. Qu, K. Wang, etc, Journal of the International Society for Prec. Eng. and Nanotechnol., 2000, 24, 329-337.
[13] Yunn-Shiuan Liao, Chao-Chang A. Chen, Choung-Lii Chao and Pei-Lum Tso, Advanced material research, 2010.
[14] L.N. Lopez de Lacalle, J.A. Sanchez, Trans. ASME, 2004, 126, 274-285.
[15] B.C. Routara, B.K. Nanda, A.K. Sahoo, B.B. Nayak, Optimization of multiple performance characteristics in abrasive jet machining using grey relation analysis, All India Manufacturing Technology Design and Research Conference (AIMTDR) 24th ,2010, 283-288.
[16] Norliana Mohd Abbas, Darius G. Solomon, Md. Fuad Bahari, A review on current research trends in electrical discharge machining (EDM), International journal of Machine tools and Manufacture 47, 2007, 1214-1228.
[17] Jujhar Singh, Ashish Gautam, R.S. Walia, Modeling of ultrasonic assisted electrical discharge machining using finite element method, All India Manufacturing Technology Design and Research Conference (AIMTDR) 24th, 2010, 183-188.uthor,"Title of the Paper", *Journal name*, Vol.X, No.X, (200X), pp.XX-XX, available online: http://xxx, last visit:28.02.2013.