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Fabrication and Optimization of MEMS based Micro Grinder

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Abstract: **-- Microfabrication technologies have been steadily advancing in recent years. Research and development are being vigorously conducted with a view towards the implementation of micromachines. Miniature of components with micro scaled features are increasing required in many industries including biomedical, Consumer electronics, automotive and defense. Mems has been identified as one of the most promising technology for 21 st Century has the potential revolutionize both industrial and consumer products. MEMS is a technology used to create tiny integrated chips that combine mechanical and electrical components. Micro grinding has a competitive edge over microfabrication processes are generally used as finishing process and generated very high surface finish. In this experimental work, fabrication of mems based micro grinding machine for the purpose of producing a very high surface finish on micro components. Dimensions of Micro grinder are 10mm x 2mm x 2mm and provide the speed of 10,000 rpm. Optimize the material removal rate of micro grinding process parameters are selected by L9 orthogonal array using 3 levels and 2 factors. Main objectives of the MEMS based micro grinder are saving energy, space, material, time and other resources. The sustainability of miniaturized production is discussed from three perspectives such as Economics, Environment and social.**

Keywords **- Micro Fabrication, MEMS, Micro Grinder, DOE, Analysis.**

I. INTRODUCTION

A. Micro grinder

Mems is a process technology used to create tiny integrated devices combines mechanical and electrical components. Mems consist of micro actuator, micro sensor and micro electronics and integrated on same silicon chip. Mems devices are very small and their components are usually microscopic levers, gears, actuators and motors have fabricated by MEMS technology. Micro grinder is a small sized grinding machine which is used to ground micro sized components in degree of accuracy.(Fig1) The micro grinder is made of Mems devices and controlled by actuator. It is tiny machine to remove the material from micro component from 1 micron into 999 micron. Micro grinding is the machining processes which improve surface quality and dimensional accuracy. Various process parameters affect the micro grinding operations are depth of cut, spindle speed, feed and wheel grain size are adverse impact of surface roughness and material removal rate are the influencing parameters of micro grinding process

II-APPLICATIONS

MEMS based Micro grinder is very much useful for dental mechanic, micro valve lapping, micro cutting, tool grinding. Micro electronics and automotive applications.

III-EXPERIMENTAL DETAILS

Work material: AISI 1020
Tool Material: SiC
Designation of Grinding Wheel
W A 36 K 5 R 17
W-Manufacture's Abrasive symbol
A- Aluminium oxide
36- Medium grain
K-Medium Grade
5-Dense Structure
R-Rubber Bond
17- Manufacture's type symbol
A-Experiment Design
The micro grinding process of AISI 1020 has been optimized by Taguchi design of experiment and analyzed by Signal to noise ratio. L9 type of design is utilized to conduct

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experiments. There are 3 levels and 2 Factors are conducted in this experiment .The spindle speed and depth of cut are the input parameters of micro grinding process and Material removal rate is selected as a response parameter is shown in Table 1.

Table 1 Levels and Factors of Micro grinding process parameters

Sl.no	Levels	Spindle speed(rpm)	Depth of Cut(mm)
1	Low	1000	0.01
2	Medium	2000	0.02
3	High	3000	0.03

Fig 1 MEMS based Micro grinder

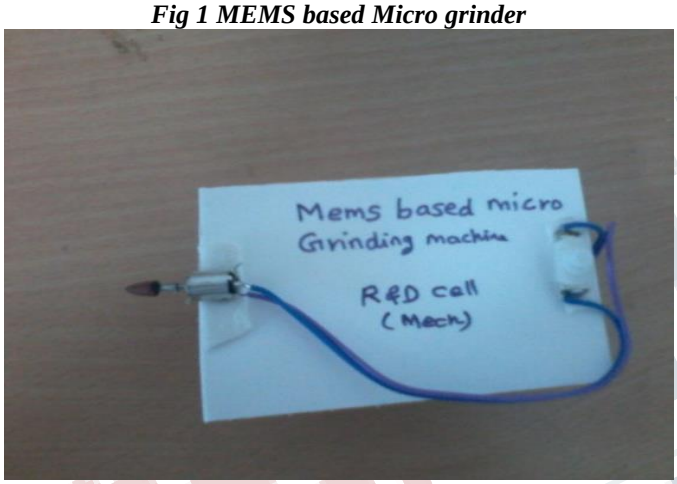

Fig 1 MEMS based Micro grinder

B. Design of Experiments via Taguchi methods

The Taguchi method involves reducing the variation in a process through robust design of experiments. The overall objective of the method is to produce high quality product at low cost to the manufacturer. The Taguchi method was developed by Dr. Genichi Taguchi of Japan who maintained that variation. Therefore, poor quality in a process affects not only the manufacturer but also the society. He developed a method for designing experiments to investigate how different parameters affect the mean and variance of a process performance characteristics that defines how well the process is functioning. The experimental design proposed by Taguchi involves using orthogonal arrays to organize the parameters affecting the process and the levels at which they should be varied and it allows for the collection of the necessary data to determine which factors most affect product quality with a minimum amount of experimentation, thus saving time and resources.

IV- OPTIMIZATION OF MEMS BASED MICRO GRINDING MACHINE.

Table 2 Micro grinding parameters of AISI-1020

Spindle speed(rpm)	Depth of cut(mm)	MRR(gram/min)
1	1	0.30
1	2	0.34
1	3	0.28
2	1	0.48
2	2	0.46
2	3	0.70
3	1	0.90
3	2	0.94
3	3	0.92

Table 2 shows that optimum parameter of micro grinding process for achieving larger material removal rate of AISI 1020 are 3 rd level of spindle speed and 2 nd Level of depth of cut

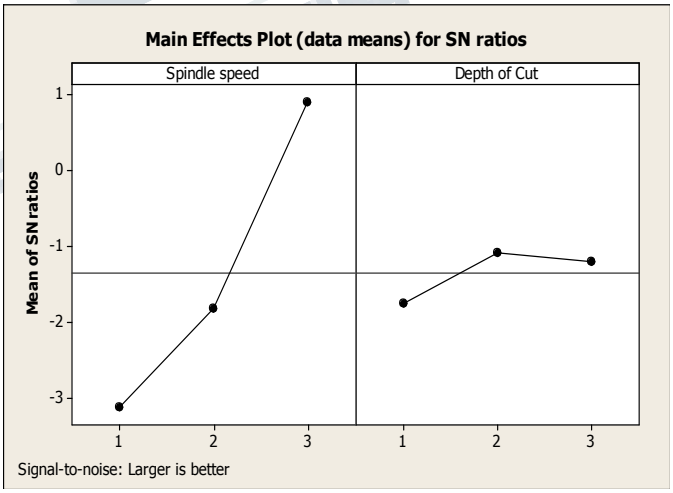

Fig 2 Main effect plot for Micro grinding process

Fig 2 shows that the signal to noise ratio of micro grinding process of AISI 1020 and represent thirdrd level of spindle speed and second level of depth of cut is an optimum parameter of micro grinding process in Mems based micro Grinding machine

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Table 3 Response Table for Signal to noise ratio (Larger is better)

Level	Spindle speed	Depth of cut
1	-3.1034	-1.7520
2	-1.8190	-1.0829
3	0.8988	-1.1886
Delta	.0021	0.6691
Rank	1	2

Table 3 shows that Spindle speed is a dominating parameter of micro grinding process of MEMS based micro grinding machine

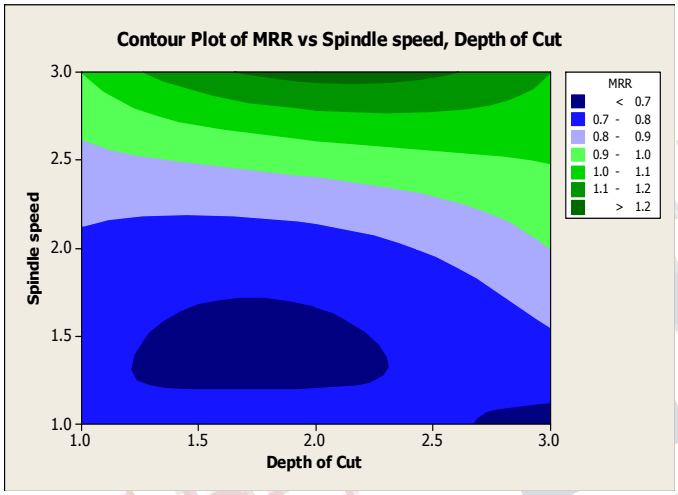

Fig3 Contour plot for micro grinding process

Fig 3 Contour plot for micro Grinding process parameter of AISI 1020 which indicate the optimum setting of micro grinding process of MEMS based Micro grinding machine are third level of spindle speed and second level of depth of cut for achieving Larger material removal rate.

V-CONCLUSION

The micro grinder has been fabricated successfully using MEMS devices and suitable for micro components. The larger material removal rate of micro grinding process are Third level of spindle speed and Second level of depth of cut. The micro grinder is saving energy, space, material, time and other resources. The sustainability of miniaturized production are discusses from three perspective such as economic, environment and social.

REFERENCES

1.Breguet, J.M., C. Schmitt and R. Clavel (2010) Micro/ Nano factory: Concept and State of the Art. Micro robotics and Micro assembly II, Proceedings of SPIE, 4194, 1-5.

2. Clévy, C., A. Hubert and N. Chaillet (2008) Flexible micro-assembly system equipped with an automated tool changer. Journal of Micro - Nano Mechatronics,4, 59-72.

3. Fruta, K. (2005) The Experimental micro factory system in Japanese national R&D project. Singapore-Japan forum on MEMS, 23 November 2000, Singapore.

4. Heikkilä, R., E. Järvenpää and R. Tuokko (2011) Micro factories: New applications of micro machine technology for small products. Manufacture 2011 conference, October 24, 78-84.

5. Heikkila, R., I. Karjalainen, J. Uusitalo, A. Vuola, and R. Tuokko (2012) Possibilities of a Micro factory in the Assembly of Small Parts and Products. First Results of the M4-project, ISAM, Japan, 166-171.

6. Heikkila, R., I. Karjalainen, J. Uusitalo, A. Vuola, and R. Tuokko (2007) Possibilities of a Micro factory in the Assembly of Small Parts and Products – First Results of the M4-project. Proceedings of the ISAM 2007, IEEE International symposium on assembly and manufacturing, Ann Arbor, Michigan, USA, 166-171.

7. Heikkilä, R., J. Uusitalo, R. Heikkilä and R. Tuokko (2010) A Micro factory Concept for Laser-Assisted Manufacturing of Personalized Implants. IWMF, 77-80.

8. Hofmann, A., B. Hummel, O. Firat, G. Bretthauer, M. Bär and M. Meyer (2011) Micros FLEX - A New Concept to Address the Needs for Adaptable Meso and Micro Assembly Lines. ISAM 2011,123-127.

9. Kawahara, N, T. suto, T. Hirano, Y. Ishikawa, itahara, N. Ooyama, & T. Ataka (2007) icrofactories: New applications of micro machine technology to manufacture of small products. Journal of Micro system Technologies, 3, 37-41.

10. Kondoh.S., K. Masui, N. Mishima, and M. Matsumoto (2012) Total performance Analysis of Product life cycle considering product value. Proceedings of CARE INNOVATION, Austria, 2012:2.101.

11. Okazaki. Y. (2010) Micro factories - A New Methodology for Sustainable Manufacturing. International Journal of Automation Technology, 4, 82-87.

12. Park, J.K., N.K. Lee, D.W. Lee and J. Song (2012) Development of Micro factory Systems for the Next Generation. 3rd Year Report, 3rd International Workshop on Micro factory Technology, 5-12.

13. Ashida, K., M.Mishima and T.Tanikawa (2000) Development of desktop machining microfactory-Trail production of miniature of machine products Japan, USA Flexible automation conference ,Ann Arbor, Michigan.3,123-129.

14. Kawakara, N., T.suto and T.Hirano (1997) Micro factories: New applications of micro machine technology to the manufacture of small products. Micro system technologies. 37-41.

15. Rahman, M.A., M.Rahman and A.Senthil kumar (2003) Fabrication of Miniature of components using micro machining. Proceedings of International conference on Mechanical Engineering (ICME 2003), 1-6.

16. Kussul,E.,D.Rachkovskij and T.Baldyk (2014) A basis for low cost manufacturing of mechanical micro devices using Micro equipment. J of Micro mechanics and Micro engineering. 6 , 410-425.

17. Shimizu, S., (2014) Reduction of machine tools in size and weight. J of JSPE.,920-925.

18. Ikawa, N., R.R. Donaldson., R.Kormanduri., W.Konig and T.H,Aachen (1991) Ultra precision metal cutting-past –present and Future, Annals of CIRP. 40, 587-594.

19. Heikkilä, R., Järvenpää, E. & Tuokko, R., (2010) Advances in the TUT Micro factory Concept, 5, 290-296.

20.Kannan,TTM., P.Ranjith Kumar., Chandrasekaran(2017)Development of MEMS based Pocket factory for Sustainable manufacturing system-Lambert Academic publishing,65-75