Towards achieving nanofinish on silicon (Si) wafer by mu-wire electro-discharge machining

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Abstract

This study investigates the use of nanopowder-mixed dielectric oil and temporary metallic coating on highly doped Si sample to achieve nanometric surface roughness using mu-WEDM operation. To achieve this, two different nanopowders were used in dielectric medium with two different temporary metallic coating in the workpiece. This is with Al and C with metallic coating of (gold) thickness 160 nm and 320 nm. Further, the discharge energy level was varied into two proximate stages (80 V/13 pF and 85 V/0.1 nF). The results show that nanopowder-assisted mu-WEDM process has improved the material removal rate (MRR) by similar to 44.5% (maximum). However, the spark gap (SG) has also been increased to a maximum of 60% than without nanopowder-assisted the mu-WEDM process. Further, it was found in our study that graphite (C) nanopowder usually generates lower spark gap as compared to aluminum (Al) nanopowder. It has also been observed that at specific mu-WEDM condition, coating thickness, and powder concentration C, Al can easily produce nanometric average surface roughness (ASR) (for C lowest ASR was 76 nm and for Al lowest ASR was 83 nm). From the findings, it can be understood that ASR can be improved maximum similar to 65% for C nanopowder and similar to 51% for Al nanopowder-assisted mu-wire electro-discharge machining as compared to conventional mu-WEDM of Si wafer. Machining stability and evenness of the machined slots were also improved by a significant margin when nanopowder-assisted mu-wire electro-discharge machining method was applied.

Keywords

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1. Title: [not available] Times Cited: 2
By: Anwar, Mohammed Muntakim.
A study on micro-patterning of polypyrrole using micro-electro-discharge machining Published: 2012
Publisher: The University of British Columbia

2. **Study of added powder in kerosene for the micro-slit machining of titanium alloy using electro-discharge machining** Times Cited: 99
By: Chow, HM; Yan, BH; Huang, FY; et al.
JOURNAL OF MATERIALS PROCESSING TECHNOLOGY Volume: 101 Issue: 1-3 Pages: 95-103 Published: APR 14 2000

3. **The effects of the silicon wafer resistivity on the performance of microelectrical discharge machining** Times Cited: 1
By: Daud, N. D.; AbuZaiter, A.; Leow, P. L.; et al.
Int J Adv Manuf Technol Pages: 1-10 Published: 2017
[Show additional data]

4. **A Discharge Separation Model for Powder Mixed Electrical Discharge Machining** Times Cited: 6
By: Ekmekci, Bulent; Yasar, Hamidullah; Ekmekci, Nihal
JOURNAL OF MANUFACTURING SCIENCE AND ENGINEERING-TRANSACTIONS OF THE ASME Volume: 138 Issue: 8 Article Number: 081006 Published: AUG 2016

5. **The application of diamond-based electrodes for efficient EDMing of silicon wafers for freedom MEMS device fabrication** Times Cited: 2
By: Fonda, P.; Chan, M. L.; Heidari, A.; et al.
PROCEEDINGS OF THE SEVENTEENTH CIRP CONFERENCE ON ELECTRO PHYSICAL AND CHEMICAL MACHINING (ISEM) Book Series: Procedia CIRP Volume: 6 Pages: 280-285 Published: 2013

6. **Nanofinishing of hard materials using micro-electrodischarge machining** Times Cited: 14
By: Jahan, M. P.; Anwar, M. M.; Wong, Y. S.; et al.
PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS PART B-JOURNAL OF ENGINEERING MANUFACTURE Volume: 223 Issue: 9 Pages: 1127-1142 Published: SEP 2009

7. **An experimental investigation into the micro-electrodischarge machining behavior of p-type silicon** Times Cited: 8
By: Jahan, Muhammad Pervej; Lieh, T. W.; Wong, Yoke San; et al.
INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY Volume: 57 Issue: 5-8 Pages: 617-637 Published: NOV 2011

8. **Study on the nano-powder-mixed sinking and milling micro-EDM of WC-Co** Times Cited: 32
By: Jahan, Muhammad Pervej; Rahman, Mustafizur; Wong, Yoke San
INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY Volume: 53 Issue: 1-4 Pages: 167-180 Published: MAR 2011

9. **EFFECT OF THE ADDITION OF GRAPHITE POWDER TO KEROSENE USED AS THE DIELECTRIC FLUID IN ELECTRICAL-DISCHARGE MACHINING** Times Cited: 101
By: JESWANI, ML
WEAR Volume: 70 Issue: 2 Pages: 133-139 Published: 1981

10. **Electroforming of copper/ZrB2 composite coating and its performance as electro-discharge machining electrodes** Times Cited: 24
By: Jin, ZJ; Zhang, M; Guo, DM; et al.
ADVANCES IN ABRASIVE TECHNOLOGY VIII Book Series: KEY ENGINEERING MATERIALS Volume: 291-292 Pages: 537-542 Published: 2005

11. **Model-based pulse frequency control for micro-EDM milling using real-time discharge pulse monitoring** Times Cited: 11
By: Jung, Jae Won; Jeong, Young Hun; Min, Byung-Kwon; et al.
JOURNAL OF MANUFACTURING SCIENCE AND ENGINEERING-TRANSACTIONS OF THE ASME Volume: 130 Issue: 3 Article Number: 031106 Published: JUN 2008

12. **Technology and research developments in powder mixed electric discharge machining (PMEDM)** Times Cited: 79
By: Kansal, H. K.; Singh, Sehijpal; Kumar, Pradeep
JOURNAL OF MATERIALS PROCESSING TECHNOLOGY Volume: 184 Issue: 1-3 Pages: 32-41 Published: APR 12 2007

13. **Numerical simulation of powder mixed electric discharge machining (PMEDM) using finite element method** Times Cited: 68
By: Kansal, H. K.; Singh, Sehijpal; Kumar, Pradeep
MATHEMATICAL AND COMPUTER MODELLING Volume: 47 Issue: 11-12 Pages: 1217-1237 Published: JUN 2008

14. **Development of mirror like surface characteristics using nano powder mixed electric discharge machining (NPMEDM)** Times Cited: 23
By: Kumar, Harmesh
INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY Volume: 76 Issue: 1-4 Pages: 105-113 Published: JAN 2015

15. **Effect of metal coating on machinability of high purity germanium using wire electrical discharge machining** Times Cited: 4
By: Lee, Sangju; Scarpulla, Michael A.; Bamberg, Eberhard
JOURNAL OF MATERIALS PROCESSING TECHNOLOGY Volume: 213 Issue: 6 Pages: 811-817 Published: JUN 2013

16. **INVESTIGATION OF SILICON WAFERING BY WIRE EDM** Times Cited: 42

By: LUO, YF; CHEN, CG; TONG, ZF
JOURNAL OF MATERIALS SCIENCE Volume: 27 Issue: 21 Pages: 5805-5810 Published: NOV 1 1992

17. A new approach on the determination of ease of machining by EDM processes — Times Cited: 31
By: Mahardika, Muslim; Tsujimoto, Takayuki; Mitsui, Kimiyuki
INTERNATIONAL JOURNAL OF MACHINE TOOLS & MANUFACTURE Volume: 48 Issue: 7-8 Pages: 746-760 Published: JUN 2008

18. Effect of micro-powder suspension and ultrasonic vibration of dielectric fluid in micro-EDM processes-Taguchi approach — Times Cited: 57
By: Prihandana, Gunawan Setia; Mahardika, Muslim; Hamdi, M.; et al.
INTERNATIONAL JOURNAL OF MACHINE TOOLS & MANUFACTURE Volume: 49 Issue: 12-13 Pages: 1035-1041 Published: OCT 2009

19. Review of Electrochemical and Electrodischarge Machining — Times Cited: 119
By: Rajurkar, K. P.; Sundaram, M. M.; Malshe, A. P.
PROCEEDINGS OF THE SEVENTEENTH CIRP CONFERENCE ON ELECTRO PHYSICAL AND CHEMICAL MACHINING (ISEM) Book Series: Procedia CIRP Volume: 6 Pages: 13-26 Published: 2013

20. Microstructuring of silicon by electro-discharge machining (EDM) .1. Theory — Times Cited: 57
By: Reynaerts, D; Heeren, PH; VanBrussel, H
SENSORS AND ACTUATORS A-PHYSICAL Volume: 60 Issue: 1-3 Pages: 212-218 Published: MAY 1997

21. Dry micro-electro-discharge machining of carbon-nanotube forests using sulphur-hexafluoride — Times Cited: 8
By: Saleh, Tanveer; Dahmardeh, Masoud; Nojeh, Alireza; et al.
CARBON Volume: 52 Pages: 288-295 Published: FEB 2013

22. Experimental study on improving mu-WEDM and mu-EDM of doped silicon by temporary metallic coating — Times Cited: 8
By: Saleh, Tanveer; Rasheed, Aous Naji; Muthalif, Asan G. A.
INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY Volume: 78 Issue: 9-12 Pages: 1651-1663 Published: JUN 2015

23. High-quality cutting of polished single-crystal silicon by wire electrical discharge machining — Times Cited: 25
By: Takino, H; Ichinohe, T; Tanimoto, K; et al.
PRECISION ENGINEERING-JOURNAL OF THE INTERNATIONAL SOCIETIES FOR PRECISION ENGINEERING AND NANOTECHNOLOGY Volume: 29 Issue: 4 Pages: 423-430 Published: OCT 2005

24. Effects of powder characteristics on electrodischarge machining efficiency — Times Cited: 122
By: Tzeng, YF; Lee, CY
INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY Volume: 17 Issue: 8 Pages: 586-592 Published: 2001

25. High efficiency slicing of low resistance silicon ingot by wire electrolytic-spark hybrid machining — Times Cited: 27
By: Wang, W.; Liu, Z. D.; Tian, Z. J.; et al.
JOURNAL OF MATERIALS PROCESSING TECHNOLOGY Volume: 209 Issue: 7 Pages: 3149-3155 Published: APR 1 2009

26. Experimental investigations into EDM behaviors of single crystal silicon carbide — Times Cited: 5
By: Zhao, Y.; Kunieda, M.; Abe, K.
PROCEEDINGS OF THE SEVENTEENTH CIRP CONFERENCE ON ELECTRO PHYSICAL AND CHEMICAL MACHINING (ISEM) Book Series: Procedia CIRP Volume: 6 Pages: 135-139 Published: 2013

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