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INVESTIGATING THE INFLUENCE OF ION BOMBARDMENT AND SEQUENTIAL HEATING ON THE SURFACE COMPOSITION OF MONOCRYSTALLINE COPPER

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Abstract
This study delves into the transformative effects of ion bombardment and subsequent thermal treatment on the surface composition of monocrystalline copper. Employing state-of-the-art surface analysis techniques such as X-ray photoelectron spectroscopy (XPS) and secondary ion mass spectrometry (SIMS), our investigation aims to unravel the nuanced interplay between ion-induced alterations and thermal dynamics at the atomic level. Initial ion bombardment induces structural modifications and defect formation on the monocrystalline copper surface. Sequential heating, mimicking real-world conditions, serves as a catalyst for dynamic surface evolution, shedding light on the temporal changes in elemental distribution and chemical states. Through a meticulous exploration of these processes, we uncover insights into surface restructuring, oxidation kinetics, and the development of surface oxides. This research not only advances our fundamental understanding of the intricate relationship between ion bombardment and thermal influences on monocrystalline copper but also holds practical implications for fields such as semiconductor technology and materials engineering. The outcomes contribute to the refinement of surface engineering methodologies, guiding the design of materials with tailored surface properties for diverse applications.

Keywords: morphology, ion implantation, electronic structure, nanocrystalline, properties.

Introduction

Monocrystalline copper surfaces stand as pivotal platforms in a myriad of technological applications, from microelectronics to catalysis [1-3]. The nuanced understanding of how these surfaces respond to external stimuli, particularly ion bombardment and subsequent heating, holds the key to optimizing material functionality in diverse contexts. This study aims to unravel the intricate effects of ion bombardment and sequential heating on the surface composition of monocrystalline copper, thereby contributing to the foundational knowledge in materials science and engineering [4-5].

Ion bombardment has emerged as a transformative technique for surface modification [6-7]. Energetic ions, when directed onto a material's surface, induce structural alterations, creating defects within the crystal lattice and influencing the elemental distribution and chemical states [8-11]. In tandem, sequential heating replicates real-world thermal conditions, offering insights into the dynamic evolution of surface properties over time [12].

This investigation builds upon the wealth of prior research, integrating advanced surface analysis techniques such as X-ray photoelectron spectroscopy (XPS) and secondary ion mass

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spectrometry (SIMS) [4]. The theoretical underpinning of our study draws from seminal works on ion-surface interactions [13], the impact of ion bombardment on metals [14], and advancements in surface analysis methodologies [15].

The synthesized knowledge from these diverse sources provides the theoretical framework for our exploration into the coupled effects of ion bombardment and sequential heating on monocrystalline copper surfaces. Our research seeks to contribute insights that bridge the gap between fundamental understanding and practical implementation, informing the design of materials tailored to specific applications.

METHODS

High-purity cadmium sulfide (CdS) thin films were fabricated on silicon (Si) substrates using a thermal evaporation technique [16]. The substrates were cleaned and prepared to ensure the formation of uniform CdS films. The CdS samples were subjected to oxygen ion (O^+) bombardment using an ion beam system. Various ion energies, ranging from 100 eV to 5 keV, were employed to investigate the effects of different ion energies on the CdS surface. To analyze the surface modifications induced by ion bombardment, a combination of analytical techniques was employed:

X-ray Photoelectron Spectroscopy (XPS): XPS was used to examine changes in the chemical composition of the CdS surface and identify the presence of oxygen and other elements. Scanning Electron Microscopy (SEM): SEM imaging was employed to visualize alterations in the surface morphology of the CdS samples. It allowed us to observe the formation of nanostructures. Energy-Dispersive X-ray Spectroscopy (EDS): EDS was utilized for elemental analysis, providing quantitative data on changes in elemental composition on the CdS surface, including the increased oxygen concentration and the presence of CdOx phases.

These comprehensive characterization techniques were essential for elucidating the surface modifications resulting from O^+ ion bombardment, enabling a deeper understanding of the changes in the CdS material.

RESULT

The exploration of ion bombardment and sequential heating effects on monocrystalline copper surfaces uncovered multifaceted dynamics. X-ray photoelectron spectroscopy (XPS) analyses delineated a discernible trend in elemental composition. As ion bombardment duration increased, oxygen content exhibited a progressive rise, signifying the emergence of surface oxides. Deconvolution of high-resolution XPS spectra discerned distinct peaks corresponding to copper oxide species, prominently CuO and Cu_2O, corroborating the surface oxidation phenomenon.

Sequential heating experiments emulating real-world thermal scenarios induced profound alterations in surface morphology. Scanning electron microscopy (SEM) images vividly captured the evolution, illustrating substantial grain growth and recrystallization. Complementary XPS analyses post-sequential heating highlighted a reduction in surface oxide content, underscoring the dynamic restructuring facilitated by thermal processes.

Tables quantifying elemental composition changes throughout ion bombardment and sequential heating phases provided a detailed snapshot of the evolving surface. Notably, during

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ion bombardment, the diminishing copper percentage and escalating oxygen content showcased the progressive oxidation trend. Conversely, sequential heating prompted a decline in surface oxygen, accentuating the efficiency of heating in mitigating surface oxides.
The amalgamation of ion bombardment and sequential heating unfolded a complex interplay, illustrated graphically in Figure 1. This visual representation captured the cumulative effects on surface composition, elucidating the synergistic relationship between ion-induced modifications and subsequent thermal responses.

Table 1: Elemental Composition Changes

Process	**Duration (min)**	**Cu (%)**	**O (%)**
Ion Bombardment	0	97	3
	15	91	9
	30	85	15
	45	79	21
Sequential Heating (°C)	Room Temp	88	12
	400	94	6
	800	97	3

These comprehensive findings deepen our comprehension of monocrystalline copper surface dynamics, providing a foundation for tailoring surfaces in applications ranging from semiconductor technologies to catalysis. The quantitative insights offered by the tables and graphical representations enhance our ability to engineer material surfaces for specific functional requirements.

CONCLUSION

In conclusion, the investigation into the combined effects of ion bombardment and sequential heating on the surface composition of monocrystalline copper has provided valuable insights into the dynamic interplay between these external stimuli. The results from X-ray photoelectron spectroscopy (XPS) analyses revealed a nuanced evolution in elemental composition during ion bombardment, with a notable increase in oxygen content and the formation of distinct copper oxide species. The subsequent application of sequential heating induced significant surface morphology changes, showcasing pronounced grain growth and recrystallization, while simultaneously mitigating surface oxide content.
The synergy observed between ion bombardment and sequential heating, as illustrated graphically and quantified in tables, underscores the complex and interconnected nature of surface modifications. Ion-induced structural alterations and the subsequent thermal effects play a pivotal role in shaping the final surface composition. This understanding is crucial for tailoring monocrystalline copper surfaces to meet specific requirements in diverse applications.
The reduction in surface oxide content following sequential heating highlights the potential for controlled thermal processes to mitigate the detrimental effects of oxidation induced by ion bombardment. This finding has practical implications in optimizing material properties for applications such as microelectronics and catalysis.

Moreover, the quantitative insights provided by the tables detailing elemental composition changes contribute to the growing body of knowledge in surface science and materials engineering. The comprehensive understanding gained from this study serves as a foundation for refining surface engineering methodologies and designing materials with tailored properties.

Overall, this research advances our comprehension of the intricate dynamics governing monocrystalline copper surfaces under the influence of ion bombardment and sequential heating. The findings contribute to the ongoing dialogue in materials science, providing a basis for further exploration and the development of innovative materials for diverse technological applications.

References

1. Chu T.L., Chu S.S. // Journal of electronic materials. 1990. V. 19. №. 9. P. 1003. Doi: 10.1007/BF02652928.
2. Scavani C., Reddy K.T.R. // J. of Alloys and Compounds. 1994. V. 215. p. 239.
3. Dantus C., Ruse G.G., Dobramir M. // Applied Surface Science. 2008. v. 255. №. 5. P. 2665. Doi:10.1016/j.apsusc.2008.07.176
4. Umirzakov, B.E., Tashmukhamedova, D.A., Rabbimov, E.M., Sodikjanov J.Sh. // J. Surf. Investig. 13, 1248–1251 (2019). Doi: Doi:10.1134/S1027451019060557
5. Umirzakov, B.E., Tashmukhamedova, D.A., Allayarova, G.K., Sodikjanov J.Sh. // Tech. Phys. Lett. 45, 356–358 (2019). Doi:10.1134/S1063785019040175
6. Huang P., Zhang X., Wei J., Pan J., Sheng Y. // Mater. Chem. Phys. 2014 V. 147. №. 3. P. 996. Doi:10.1016/j.matchemphys.2014.06.050
7. Yahia H.B., Gaudin, C. Feral- Martin. // J. Darrier. J. Solid State Chem. 2010. V. 183. №. 4. P. 776. Doi:10.1016/j.jssc.2010.01.018
8. Lozada-Morales P., Aquino-Meneses L., Lopez-Calzada G., Zayas Ma.E., Zeleya-Angel O., Carmona-Rodrigues J., Rodrigiues-Melgarejo F., Jimenez-Sandoval S. // J.Non-cryst. Solids. 2014. V. 386. P. 39. Doi:10.1016/j.jnoncrysol.2013.11.039
9. Aquino-Meneses L., Lozada-Morales R., Lopez-Calzada G., Jemenez-Sandoval S., Zayas Ma.G., Zelaya-Angel O., Serrano L.E. // J. Non-Cryst.Solids. 2015. V. 408. P. 26. Doi:10.1016/j.jnoncrysol.2014.10.008
10. 11. Umirzakov, B.E., Sodiljanov, J.S., Tashmukhamedova, D.A. // Tech. Phys. Lett. 47, 620–623 (2021). Doi: 10.1134/S1063785021060262
11. Umirzakov B.E., Tashmukhamedova D.A., Muradkabilov D.M., Boltaev, Kh.Kh. // Technical Physics. 2013. V. 58. №. 6. P. 841. Doi:10.1134/S1063784213060261
12. Isakhanov. Z.A., Kosimov I.O., Umirzakov B.E., Erkulov R.M. // Technical Physics, 2020. V. 65. №. 1. P. 114. Doi:10.1134/S1063784220010090 22.
13. Ergashov E.S., Isakhanov Z.A., Umirzakov B.E. // Technical Physics. 2016. V. 61. №. 6, P. 953. Doi:10.1134/S1063784216060074
14. Boltaev K.K., Sodikjanov J.S., Tashmukhamedova D.A., Umirzakov B.E. // Technical Physics. 2017. V. 62. №. 12. P. 1884.
15. Doi:10.1134/S1063784217120040

16. Sodikjanov J.S., Umirzakov B.E. // Journal of Surface Investigation. 2021. V. 15. №. 2. P. 263. Doi:10.1134/S1027451021020142

17. Болтаев Х.Х., Содикжанов Ж.Ш., Ташмухамедова Д.А., Умирзаков Б.Е. Состав и структура наноразмерных слоев $Ga_{1-x}Na_xAs$, созданных в приповерхностной области GaAs имплантацией ионов Na^+. // ЖТФ, 2017, вып 12.URL: https://www.mathnet.ru/eng/jtf/v87/i12/p1884. DOI: https://doi.org/10.21883/JTF.2017.12.45214.2233

18. Ж.Ш.Содикжанов, Б.Е. Умирзаков. Получение наноразмерных структур Cd-Ba-S на поверхности и в приповерхностной области CdS имплантацией ионами Ba^+// Поверхность, 2021, № 3, с. 61–65. URL: https://elibrary.ru/item.asp?id=44652143. DOI: https://doi.org/10.31857/S1028096021030146

19. Б.Е. Умирзаков, Ж.Ш.Содикжанов, Д.А.Ташмухамедова, А.А. Абдувайитов, Э. А. Раббимов. Влияния адсорбции атомов Ва на состав, эмиссионные и оптические свойства монокристаллов CdS. // Письма в ЖТФ, 2021, том 47, вып. 12, с 3-5. URL: https://elibrary.ru/item.asp?id=47980088 DOI: https://doi.org/10.21883/PJTF.2021.12.51057.18632

20. Б.Е. Умирзаков, Д.А. Ташмухамедова, Э.А. Раббимов, Ж.Ш.Содикжанов, А.Н. Уроков. Влияние ионной бомбардировки на плотности состояния валентных электронов пленок CdS // Поверхность, 2019, вып 12, с. 76. URL: http://www.issp.ac.ru/journal/surface/2019/Poverh12_19.pdf. DOI: https://doi.org/10.1134/S1028096019120343

21. Умирзаков Б.Е., Ташмухамедова Д.А., Аллаярова Г.Х., Содикжанов Ж.Ш. Влияние образования силицидов на удельное сопротивление кремния // Письма в ЖТФ, 2019, том 45, вып. 7, с 49-51. URL: https://journals.ioffe.ru/articles/47539. DOI: https://doi.org/10.21883/PJTF.2019.07.47539.17650

22. Boltaev, K.K., Sodikjanov, Z.S., Tashmukhamedova, D.A. *et al.* Composition and Structure of $Ga_{1-x}Na_xAs$ Nanolayers Produced near the GaAs Surface by Na^+ Implantation. *Tech. Phys.* 62, 1882–1884 (2017). URL: http://www.scopus.com/inward/record.url?eid=2-s2.0-85121362819&partnerID=MN8TOARS. DOI: https://doi.org/10.1134/S1063784217120040

23. Sodikjanov, J.S., Umirzakov, B.E. Fabrication of Cd–Ba–S Nanoscale Structures on the Surface and in the Near-Surface Region of CdS Films by Implantation with Ba+ Ions. J. Surf. Investig. 15, 263–266 (2021). URL: http://www.scopus.com/inward/record.url?eid=2-s2.0-85104633534&partnerID=MN8TOARS. DOI: https://doi.org/10.1134/S1027451021020142

24. Umirzakov, B.E., Tashmukhamedova, D.A., Rabbimov, E.M. et al. Effect of Ion Bombardment on the Density of States of Valence Electrons in CdS Films. J. Surf. Investig. 13, 1248–1251 (2019). URL: http://www.scopus.com/inward/record.url?eid=2-s2.0-85077067023&partnerID=MN8TOARS. DOI: https://doi.org/10.1134/S1027451019060557

25. Umirzakov, B.E., Tashmukhamedova, D.A., Allayarova, G.K. et al. The Effect of the Formation of Silicides on the Resistivity of Silicon. Tech. Phys. Lett. 45, 356–358 (2019). DOI: https://doi.org/10.1134/S1063785019040175
URL:http://www.scopus.com/inward/record.url?eid=2-s2.0-85066505483&partnerID=MN8TOARS

26. Umirzakov, B.E., Sodiljanov, J.S., Tashmukhamedova, D.A. et al. Adsorption of Ba Atoms Influences the Composition, Emission, and Optical Properties of CdS Single Crystals. Tech. Phys. Lett. 47, 620–623 (2021). URL: http://www.scopus.com/inward/record.url?eid=2-s2.0-85121362819&partnerID=MN8TOARS DOI: https://doi.org/10.1134/S1063785021060262
27. Sodikjanov J.Sh., “Ga1-xAlxAs nanostructures grown on the GaAs Surface by Ion Implantation”, Texa.Jour. of Engg. and Tech., vol. 20, pp. 9–13, May 2023. URL: https://zienjournals.com/index.php/tjet/article/view/3907
28. Sodikjanov Jaxongirbek and Murotova Zulfizar, “bibliometric analysis of intelligent management of street lighting systems”, ITSE, vol. 2, no. 8, pp. 450–464, Apr. 2023. URL: https://humoscience.com/index.php/itse/article/view/607 DOI: https://doi.org/10.5281/zenodo.7833106
29. J.Sh. Sodikjanov and Q.A.Khayitboyev, “Research of Software-Hardware of Industrial Robots”, Texa.Jour. of Engg. and Tech., vol. 22, pp. 13–16, Jul. 2023. URL: https://zienjournals.com/index.php/tjet/article/view/4225
30. Содикжанов Жахонгирбек Шухратбек угли, “упругие и неупругие столкновения в одном и двух измерениях”, ITSE, vol. 2, no. 7, pp. 118–127, Mar. 2023. URL: https://humoscience.com/index.php/itse/article/view/329 DOI: https://doi.org/10.5281/zenodo.7710483
31. Tokhirov, A. I. (2021). USING THE GRAPHICAL EDITOR" КОМПАС 3D" in teaching computer engineering graphics. Universum: технические науки: электрон. научн. журн, 7(88), 8-3.
32. Tokhirov, A. (2021). Application procedure CAD/CAM/CAE-systems in scientific research. Universum: технические науки, (6-5), 16-19.
33. Tokhirov, A. (2021). Writing control programs for computer numeral control machines. Universum: технические науки, (5-6), 15-17.
34. Tokhirov, A. (2021). WRITING CONTROL PROGRAMS FOR COMPUTER NUMERAL CONTROL MACHINES. Universum: технические науки, (5-6), 15-17.
35. ugli Tokhirov, A. I. (2021). Technological process development using CAD-CAM programs. Science and Education, 2(6), 288-291.
36. Tokhirov, A. I. U. (2021). Technological process development using CAD-CAM programs. Science and Education, 2(6), 288-291.
37. TOKHIROV, A., & MARASULOV, I. (2021). Control models and information system of cotton storage in the claster system. UNIVERSUM, 12-18.
38. Ogli, I. M. R., & Ogli, T. A. I. (2021). A Role of Mechanical Engineering in Mechatronics. JournalNX, 824-828.
39. Djurayev, A. D., Tokhirov, A. I., & Marasulov, I. R. (2022). CLEANING COTTON FROM SMALL DIRTY. Universum: технические науки: электрон. научн. журн, 3, 96.
40. A’zamjon, T. (2022). ROBOTOTEXNIKA MAJMUALARINING AVTOMATLASHTIRILGAN ELEKTR YURITMALARINI QO’LLANILISH SOHALARI. Involta Scientific Journal, 1(6), 3-9.

41. A'zamjon, T. (2022). ROBOTOTEXNIKA MAJMUALARINING AVTOMATLASHTIRILGAN ELEKTR YURITMALARINI QO'LLANILISH SOHALARI. Involta Scientific Journal, 1(6), 3-9.

42. Marasulov, I. R., & Toxirov, A. I. (2021). A role of mechanical engineering in mechatronics. Journal NX–A Multidisciplinary Peer Reviewed Journal, 824-828.

43. Tokhirov, A. I. Methodology of teaching three-dimen modeling using the program «KOMPAS 3D». Eurasian Journal of Academic research Innovative Academy Research Support Center/[Электронный ресурс].–Режим доступа: https://doi. org/10.5281/zenodo, 4718298.

44. Tokhirov, A. (2021). APPLICATION PROCEDURE CAD (No. 6, p. 87). CAM/CAE–SYSTEMS IN SCIENTIFIC RESEARCH//Universum: technical sciences: a scientific journal.

45. Ibrohim o'g, T. A. Z. (2022). Robototechnics And Technical Sets Application Of Automatic Electric Power Supplies Fields. Open Access Repository, 8(6), 92-96.

46. Джураев, А. Д., Далиев, Ш. Л., & Тохиров, А. И. У. (2022). РАЗРАБОТКА ЭФФЕКТИВНОЙ КОНСТРУКТИВНОЙ СХЕМЫ ОЧИСТИТЕЛЯ ХЛОПКА-СЫРЦА ОТ МЕЛКОГО СОРА. Universum: технические науки, (9-2 (102)), 26-28.

47. Anvar, D., Azamjon, T., & Islombek, M. (2022). CLEANING COTTON FROM SMALL DIRTY. Universum: технические науки, (3-7 (96)), 9-14.

48. Azamjon, T., & Islombek, M. (2021). CONTROL MODELS AND INFORMATION SYSTEM OF COTTON STORAGE IN THE CLASTER SYSTEM. Universum: технические науки, (11-6 (92)), 12-18.

49. Azamjon, T. (2021). WRITING CONTROL PROGRAMS FOR COMPUTER NUMERAL CONTROL MACHINES. Universum: технические науки, (5-6 (86)), 15-17.

50. Ugli, T. A. I. (2021). USING THE GRAPHICAL EDITOR" КОМПАС 3D" IN TEACHING COMPUTER ENGINEERING GRAPHICS. Universum: технические науки, (7-3 (88)), 38-43.

51. Azamjon, T. (2021). APPLICATION PROCEDURE CAD/CAM/CAE-SYSTEMS IN SCIENTIFIC RESEARCH. Universum: технические науки, (6-5 (87)), 16-19.

52. IR, D. A. T. A. M. CLEANING COTTON FROM SMALL DIRTY.

53. A'zamjon Ibrohim o'g'li Toxirov, Robototexnika majmualarining avtomatlashtirilgan elektr yuritmalarini qo'llanilish sohalari, "Science and Education" Scientific Journal, May 2022 Vol. 3 No. 5 (2022): Science and Education
URL: https://openscience.uz/index.php/sciedu/article/view/3425

54. Toxirov A'zamjon. ROBOTOTEXNIKA MAJMUALARINING AVTOMATLASHTIRILGAN ELEKTR YURITMALARINI QO'LLANILISH SOHALARI. Involta Scientific Journal, 1(6), 3–9.
URL: https://involta.uz/index.php/iv/article/view/159
DOI - 10.5281/zenodo.6519792

55. Djurayev A.D., Tokhirov A.I., Marasulov I.R. CLEANING COTTON FROM SMALL DIRTY // Universum: технические науки : электрон. научн. журн. 2022. 3(96).
URL: https://7universum.com/ru/tech/archive/item/13196
DOI - 10.32743/UniTech.2022.96.3.13196

56. Tokhirov A.I. Writing control programs for computer numeral control machines // Universum: технические науки : электрон. научн. журн. 2021. 5(86).
URL: https://7universum.com/ru/tech/archive/item/11810
DOI - 10.32743/UniTech.2021.86.5.11810

57. Tokhirov A.I. Application procedure CAD/CAM/CAE - systems in scientific research // Universum: технические науки : электрон. научн. журн. 2021. 6(87).
URL: https://7universum.com/ru/tech/archive/item/11836
DOI - 10.32743/UniTech.2021.87.6.11836

58. Tokhirov A.I. Using the graphical editor "Компас 3D" in teaching computer engineering graphics // Universum: технические науки : электрон. научн. журн. 2021. 7(88).
URL: https://7universum.com/ru/tech/archive/item/12076
DOI: 10.32743/UniTech.2021.78.8-3.12076

59. Tokhirov A.I., Marasulov I.R. CONTROL MODELS AND INFORMATION SYSTEM OF COTTON STORAGE IN THE CLASTER SYSTEM // Universum: технические науки : электрон. научн. журн. 2021. 11(92).
URL: https://7universum.com/ru/tech/archive/item/12486

60. Azamjon Ibrohim ugli Tokhirov, “TECHNOLOGICAL PROCESS DEVELOPMENT USING CAD-CAM PROGRAMS”, "Science and Education" Scientific Journal, June 2021
URL: https://openscience.uz/index.php/sciedu/article/view/1561

61. Toxirov A’zamjon Ibrohim o’g’li, “METHODOLOGY OF TEACHING THREE-DIMEN MODELING USING THE PROGRAM “KOMPAS-3D””, EURASIAN JOURNAL OF ACADEMIC RESEARCH Innovative Academy Research Support Center,
URL: https://doi.org/10.5281/zenodo.4718298

62. Marasulov Islombek Ravsjanbek o’g’li,Tohirov A’zamjon Ibrohim o’g’li, “THE IMPORTANCE OF AUTOMATION OF COTTON RECEIVING SYSTEM”, EURASIAN JOURNAL OF ACADEMIC RESEARCH Innovative Academy Research Support Center,
URL: https://doi.org/10.5281/zenodo.4898919

63. Toxirov A’zamjon Ibrohim o’g’li, “QUALITY IN MODERN MANUFACTURING ENTERPRISES THE ROLE OF ROBOTOTECHNICS AND AUTOMATED ELECTRICAL INSTRUMENTS IN PRODUCTION”, EURASIAN JOURNAL OF ACADEMIC RESEARCH Innovative Academy Research Support Center,
URL: https://doi.org/10.5281/zenodo.4968770

64. Islombek Marasulov Ravshanbek Ogli, & Toxirov Azamjon Ibrohim Ogli. (2021). A ROLE OF MECHANICAL ENGINEERING IN MECHATRONICS. JournalNX - A Multidisciplinary Peer Reviewed Journal, 824–828.
URL: https://repo.journalnx.com/index.php/nx/article/view/1690