LITIY IONLARI KIRITILGAN KALIY ANTIMONAT-VOLFRAMATLARNI QATTIQ FAZALI REAKSIYA YORDAMIDA SINTEZ QILISH VA ULURNI TAYYORLASH TEXNOLOGIYASI

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Annotatsiya. xLi_2CO_3-$(y-x)K_2CO_3$-ySb_2O_3-$(2-y)WO_3$ tizimida fazalar hosil bo'lish xususiyatlari o'rganildi va qattiq fazali reaksiyasi ishlab chiqildi. Harorat 1123 K bo'lganida, piroxlor tipidagi tuzilishga ega $Li_xK_{y-x}Sb_yW_{2-y}O_6$ o'zgaruvchan fazalar hosil bo'lishi aniqlandi.

KIRISH

Yoqilg'i elementlari uchun anod va katod materiallarini, shuningdek, hozirgi an'anaviy elektrolitlar bilan raqobatlasha oladigan yangi kation va anion o'tkazuvchi materiallarni izlashga katta e'tibor qaratilmoqda. Bugungi kunga kelib, ishqoriy kationlarga nisbatan yuqori o'tkazuvchanlikka ega bo'lgan, har xil sinflar va tuzilish turlariga mansub o'nlab qattiq elektrolitlar sintez qilingan [1-6].

Ta'kidlash joizki, hozirgacha qattiq fazalarning termal barqarorligi, nuqsonli piroxlor tipidagi qattiq eritmalarning barqarorlik chegaralarini aniqlash, ionlarning strukturadagi kristallografik pozitsiyalar bo'yicha joylashuvi va olingan birikmalarda ionlarni tashish mexanizmi yaxshi tushunilmagan bo'lib qolmoqda. Shunday qilib, oksidli tizimlarning fazaviy diagrammasi, hosil bo'lish shartlari va xossalari haqida yangi ma'lumot olish kondensatsiyalangan moddalar fizikasi va zamonaviy materialshunoslikning dolzarb muammolaridan biridir [7-9].

Asosiy qism. Murakkab oksidlarni tayyorlashda ishlatiladigan materiallar: Shu munosabat bilan, bu ishning maqsadi xLi_2CO_3-$(y-x)K_2CO_3$-ySb_2O_3-$(2-y)WO_3$ tizimida fazalar hosil bo'lish jarayonlarini o'rganish, hosil bo'lgan fazalarning tarkibi va tuzilishini aniqlashdir. Bunday birikmalarni tayyorlashning eng keng tarqalgan usullaridan biri qattiq fazali reaksiya usuli hisoblanadi. Namunalarning sintezi standart qattiq fazali texnologiya bo'yicha kaliy karbonatlarning K_2CO_3 boshlang'ich reaktivlari va reaktivlaridan, shuningdek, litiy karbonatlari (Li_2CO_3), surma oksidlari (Sb_2O_3), volfram (WO_3) dan amalga oshirildi [9-11].

Murakkab oksidlar sintezi va ularni tayyorlash. Gidratlangan namlikni olib tashlash uchun bir valentli metall karbonatlar 500-600 K haroratda mufel pechida ikki soat davomida issiqlik bilan ishlov berildi. Boshlang'ich reagentlarning tortilgan qismlari tegishli qattiq fazali reaktsiyalar komponentlarining molyar nisbatlaridan hisoblab chiqilgan [12-17]. Oksidlar va karbonatlar kukunlari aralashmalari oz

miqdordagi etil spirti qo'shilgan holda maxsus o'g'irchada yaxshilab maydalangan va havoda toblangan: T_1=700 K, T_2=900 K va T_3=1123 K.

Биз қуйида изотермик термогравиметрия ($\mu_э$) ва назарий ҳисобланган ($\mu_т$) (T=123 K) xLi_2CO_3-$(y-x)K_2CO_3$-ySb_2O_3-$(2-y)WO_3$ тизими намуналари бўйича массасининг x = 0.5 да нисбий ўзгаришини кўришимиз мумкин:

1) $0.5K_2CO_3 + 0.5Li_2CO_3 + Sb_2O_3 + 2WO_3+0.5O_2 \rightarrow 2K_{0.5}Li_{0.5}SbWO_6 + 0.5CO_2\uparrow$;

y= 1.0 (Mole ratio of reactants)

$M_1 = (0.5K_2CO_3) = 0.5\bullet(2\bullet39.09+12.01+48)=276.38$

$M_2 = (0.5Li_2CO_3) = 0.5\bullet(2\bullet6.9+12.01+48)=36.905$

$M_3 = (Sb_2O_3) = 2\bullet121.75+48=291.5$

$M_4 = (2WO_3) = 2\bullet(183.85+48)=463.7$

$M_5 = (2K_{0.5}Li_{0.5}SbWO_6) =2\bullet(0.5\bullet39.09+0.5\bullet6.9+121.75+183.85+96)=849.19$

$x_5 = 1$

$$x_1 = \frac{x_5 \times M_1}{M_5} = \frac{1 \times 276.38}{849.19} = 0.325 \text{ mg}$$

$$x_2 = \frac{x_5 \times M_2}{M_5} = \frac{1 \times 36.905}{849.19} = 0.043 \text{ mg}$$

$$x_3 = \frac{x_5 \times M_3}{M_5} = \frac{1 \times 291.5}{849.19} = 0.343 \text{ mg}$$

$$x_4 = \frac{x_5 \times M_4}{M_5} = \frac{1 \times 463.7}{849.19} = 0.546 \text{ mg}$$

2) $0.625K_2CO_3+0.5Li_2CO_3+1.125Sb_2O_3 + 1.75WO_3+0.625O_2 \rightarrow 2K_{0.625}Li_{0.5}Sb_{1.125}W_{0.875}O_6+0.625CO_2\uparrow$;

y= 1.125 (Mollar nisbati)

$M_1 = (0.625K_2CO_3) = 0.625\bullet(2\bullet39.09+12.01+48) = 86.36$

$M_2 = (0.5Li_2CO_3) = 0.5\bullet(2\bullet6.9+12.01+48) = 101.46$

$M_3 = (1.125Sb_2O_3) = 1.125\bullet(2\bullet121.75+48) = 327.94$

$M_4 = (1.75WO_3) = 1.75(183.85+48) = 405.7$

$M_5=(2K_{0.625}Li_{0.5}Sb_{1.125}W_{0.875}O_6)=2\bullet(0.625\bullet39.09\bullet0.5\bullet6.9+1.125\bullet121.75+0.875\bullet183.85+96)= 840$

$x_5 = 1$

$$x_1 = \frac{x_5 \times M_1}{M_5} = \frac{1 \times 86.36}{840} = 0.102 \text{ mg}$$

$$x_2 = \frac{x_5 \times M_2}{M_5} = \frac{1 \times 101.46}{840} = 0.121 \text{ mg}$$

$$x_3 = \frac{x_5 \times M_3}{M_5} = \frac{1 \times 327.94}{840} = 0.391 \text{ mg}$$

$$x_4 = \frac{x_5 \times M_4}{M_5} = \frac{1 \times 405.7}{840} = 0.483 \text{ mg}$$

3) $0.75K_2CO_3+0.5Li_2CO_3+1.25Sb_2O_3+1.5WO_3+ 0.75O_2 \rightarrow 2K_{0.75}Li_{0.5}Sb_{1.25}W_{0.75}O_6+0.75CO_2\uparrow$;

y= 1.25 (Mollar nisbati)

$M_1 = (0.75K_2CO_3) = 0.75\bullet(2\bullet39.09+12.01+48) = 103.6$

$M_2 = (0.5Li_2CO_3) = 0.5\bullet(2\bullet6.9+12.01+48) = 36.9$

$M_3 = (1.25Sb_2O_3) = 1.25\bullet(2\bullet121.75+48) = 364.4$

$M_4 = (1.5WO_3) = 1.5\bullet (183.85+48) = 347.7$

$M_5 =(2K_{0.75}Li_{0.5}Sb_{1.25}W_{0.75}O_6)=2\bullet(39.09\bullet0.75+0.5\bullet6.9+121.75\bullet1.25+183.85\bullet0.75+96) = 830.8$

$$x_5 = 1$$

$$x_1 = \frac{x_5 \times M_1}{M_5} = \frac{1 \times 103.6}{830.8} = 0.125 \text{ mg}$$

$$x_2 = \frac{x_5 \times M_2}{M_5} = \frac{1\times36.9}{830.8} = 0.044 \text{ mg}$$

$$x_3 = \frac{x_5 \times M_3}{M_5} = \frac{1\times364.4}{830.8} = 0.439 \text{ mg}$$

$$x_4 = \frac{x_5 \times M_4}{M_5} = \frac{1\times347.7}{830.8} = 0.418 \text{ mg}$$

4) $0.875K_2CO_3+0.5Li_2CO_3+1.375Sb_2O_3 + 1.25WO_3+0.875O_2 \rightarrow 2K_{0.875}Li_{0.5}Sb_{1.375}W_{0.625}O_6+0.875CO_2\uparrow$;

y= 1.375 (Mollar nisbati)

$M_1 = (0.875K_2CO_3) =0.875\bullet(2\bullet39.09+12.01+48) = 122$

$M_2 = (0.5Li_2CO_3) =0.5\bullet(2\bullet6.9+12.01+48) = 36.9$

$M_3 = (1.375Sb_2O_3) = 1.375\bullet(2\bullet121.75+48) = 400.8$

$M_4 = (1.25WO_3) = 1.25\bullet (183.85+48) = 289.8$

$M_5=(2K_{0.875}Li_{0.5}Sb_{1.375}W_{0.625}O_6)=2\bullet(39.09\bullet0.875+0.5\bullet6.9+121.75\bullet1.375+183.85\bullet0.625+96)=639.9$

$$x_5 = 1$$

$$x_1 = \frac{x_5 \times M_1}{M_5} = \frac{1 \times 122}{639.9} = 0.191 \text{ mg}$$

$$x_2 = \frac{x_5 \times M_2}{M_5} = \frac{1\times36.9}{639.9} = 0.058 \text{ mg}$$

$$x_3 = \frac{x_5 \times M_3}{M_5} = \frac{1\times400.8}{639.9} = 0.626 \text{ mg}$$

$$x_4 = \frac{x_5 \times M_4}{M_5} = \frac{1\times289.8}{639.9} = 0.453 \text{ mg}$$

Shakllangan fazalar tarkibi izotermik termogravimetriya ma'lumotlari bo'yicha namunalarni VLR-200 ikkinchi aniqlik sinfining analitik balansida tortish yo'li bilan hisoblab chiqilgan. Bu hisob - kitoblar olingan birikmalarning kimyoviy tarkibini

aniqlash imkonini berdi [18-22].

XULOSA

Aralashmalar xLi_2CO_3-$(y-x)K_2CO_3$-ySb_2O_3-$(2-y)WO_3$ reagentlarining har xil nisbati bilan tayyorlanadi, *x* aralashmaning tarkibiy qismlarining molyar nisbati 0.125 qadam bilan $1.0 \leq y \leq 1.375$ oralig'ida o'zgarib turadi.

Foydalanilgan adabiyotlar

1. Bozorov, Kh N., O. O. Mamatkarimov, and B. T. Abdulazizov. "Electric and ionic conductivity of potassium antimony tungstate with addition of alkali metals." *«Узбекский физический журнал»* 24.2 (2022): 129-132.
2. Uktamaliyev, B. I., et al. "Determination of transport properties for polymer electrolytes containing LiTf and MgTf2 salts." *Molecular Crystals and Liquid Crystals* 763.1 (2023): 17-27.
3. Mamatkarimov, O. O., R. Khamidov, and A. Abdukarimov. "The relative current change, concentration, and carrier mobility in silicon samples doped nickel and at pulse hydrostatic pressure." *Materials Today: Proceedings* 17 (2019): 442-445.
4. Uktamaliyev, B. I., et al. "Determination of transport properties for polymer electrolytes containing LiTf and MgTf2 salts." *Molecular Crystals and Liquid Crystals* 763.1 (2023): 17-27.
5. Mamatkarimov, O., B. Uktamaliyev, and A. Abdukarimov. "Temperature dependence of active and reactive impedances of PMMA-EC-LITF2 solid polymer electrolytes." *НАУЧНЫЕ ОСНОВЫ ИСПОЛЬЗОВАНИЯ ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ НОВОГО УРОВНЯ И СОВРЕМЕННЫЕ ПРОБЛЕМЫ АВТОМАТИЗАЦИИ* (2022): 366.
6. Manjuladevi, R., et al. "Preparation and characterization of blend polymer electrolyte film based on poly (vinyl alcohol)-poly (acrylonitrile)/MgCl 2 for energy storage devices." *Ionics* 24 (2018): 1083-1095.
7. Mamatkarimov, O., A. Abdukarimov, and B. Uktamaliev. "ABOUT THE CHARACTERISTICS OF MULTILAYER THIN-FILM STRUCTURES WITH DYES BASED ON TITANIUM DIOXIDE." *Euroasian Journal of Semiconductors Science and Engineering* 3.40 (2021): 26-29.
8. Odiljon, Mamatkarimov, Uktamaliyev Bekzod, and Abdullaziz Abdukarimov. "Determination of ionic conductivity of polymer electrolytes in li-ion batteries using electrochemical impedance spectroscopy." *ACADEMICIA: An International Multidisciplinary Research Journal* 11.7 (2021): 141-146.
9. Ikramov, R. G., et al. "Calculation of the interband absorption spectra of amorphous semiconductors using the Kubo-Greenwood formula." *Journal of Applied Science and Engineering* 25.5 (2021): 919-924.
10. Ikramov, Rustamjon G., et al. "Calculation of the Density of the Distribution of Electronic States in the Conduction Band from the Fundamental Absorption Spectra of Amorphous Semiconductors." *East European Journal of Physics* 4 (2023): 153-158.
11. Ikramov, Rustamjon G., et al. "Dangerous Bonds Individual of Hydrogenated Amorphous Silicon and Defect Absorption Spectra." *East European Journal of Physics* 4 (2023): 244-250.
12. Абдулазизов, Б. Т., et al. "Дефекты, характерные для гидрогенизированных аморф-ных полупроводников, и спектры дефектного поглощения." *«Узбекский физический журнал»* 25.3 (2023).
13. Ikramov, R. G., et al. "Kubo-greenwood Formula For The Exponential Absorption Region Of Amorphous Semiconductors And Distribution Of The Density Of Electronic States In The Tail Of The Conduction Band." *Journal of Applied Science and Engineering* 26.8 (2022): 1167-1171.

14. Абдулазизов, Б. Т., et al. "Область экспоненциального поглощения аморфных полупроводников." *«Узбекский физический журнал»* 24.2 (2022): 96-99. Икрамов, Рустамжон, et al. "СПЕКТРЫ КОЭФФИЦИЕНТА ДЕФЕКТНОГО ПОГЛОЩЕНИЯ АМОРФНЫХ ПОЛУПРОВОДНИКОВ." *Scientific Collection «InterConf»* 107 (2022): 409-420.
15. Муминов, Х. А., Б. Султонов, and О. Т. Холмирзаев. "РАСЧЕТ РАСПРЕДЕЛЕНИЕ ПЛОТНОСТИ ЭЛЕКТРОННЫХ СОСТОЯНИЙ В ВАЛЕНТНОЙ ЗОНЕ ИЗ СПЕКТРА МЕЖЗОННОГО ПОГЛОЩЕНИЯ АМОРФНЫХ ПОЛУПРОВОДНИКОВ." *EDITOR COORDINATOR* (2021): 384.
16. Икрамов, Рустамжон, et al. "СПЕКТРЫ КОЭФФИЦИЕНТА ДЕФЕКТНОГО ПОГЛОЩЕНИЯ АМОРФНЫХ ПОЛУПРОВОДНИКОВ." *Scientific Collection «InterConf»* 107 (2022): 409-420.
17. Maxmudovich, To‘xliyev Mansur. "PAST POTENSIALLI QUYOSH QURITGICHLARNI SAMARADORLIGINI OSHIRISH." *Educational Research in Universal Sciences* 1.6 (2022): 79-86.
18. Yusupov, Elmurod Kuchkarboyevich. "STUDYING PROPERTIES OF ROTATIONAL STATES 156Gd."
19. Байматов, П. Ж., et al. "ВЛИЯНИЕ ИЗМЕНЕНИЯ ХИМИЧЕСКОГО ПОТЕНЦИАЛА НА ТЕПЛОЕМКОСТЬ КВАЗИДВУМЕРНОГО ЭЛЕКТРОННОГО ГАЗА." *«Узбекский физический журнал»* 20.6 (2018).
20. Ravshanjon o’g, G‘aybullayev Dostonbek. "QUYOSH ENERGIYASI VA UNDAN FOYDALANISH." *O'ZBEKISTONDA FANLARARO INNOVATSIYALAR VA ILMIY TADQIQOTLAR JURNALI* 2.19 (2023): 1574-1576.
21. Ikramov, Rustamjon G., et al. "Calculation of the Density of the Distribution of Electronic States in the Conduction Band from the Fundamental Absorption Spectra of Amorphous Semiconductors." *East European Journal of Physics* 4 (2023): 153-158.
22. Ikramov, Rustamjon G., et al. "Dangerous Bonds Individual of Hydrogenated Amorphous Silicon and Defect Absorption Spectra." *East European Journal of Physics* 4 (2023): 244-250.
23. Ikramov, R. G., et al. "Kubo-greenwood Formula For The Exponential Absorption Region Of Amorphous Semiconductors And Distribution Of The Density Of Electronic States In The Tail Of The Conduction Band." *Journal of Applied Science and Engineering* 26.8 (2022): 1167-1171.
24. Ikramov, Rustamzhon Gulomzhonovich, Mashkhura Anvarbekovna Nuriddinova, and Xurshid Adhamjon Muminov. "A new method for determining the density distribution of electronic states on the tail of the valence band of amorphous semiconductors Se _x S _1-x." *Optics and spectroscopy* 129.11 (2021): 1382-1386.
25. Икрамов, Р. Г., М. А. Нуриддинова, and Х. А. Муминов. "Вычисление плотности электронных состояний в валентной зоне из экспериментального спектра межзонного поглощения аморфных полупроводников." *Журнал прикладной спектроскопии* 88.3 (2021): 378-382.
26. Икрамов, Рустамжон Гуломжонович, Машхура Анварбековна Нуриддинова, and Хуршид Адхамжон угли Муминов. "Новый метод определения распределения плотности электронных состояний в хвосте валентной зоны аморфных твердых растворов Se _x S _1-x." *Оптика и спектроскопия* 129.11 (2021): 1382-1386.
27. Ikramov, Rustam, et al. "Temperature Dependence of Urbach Energy in Non-Crystalline Semiconductors." *Optics and Photonics Journal* 10.9 (2020): 211-218.

28. Абдулазизов, Б. Т., et al. "Расчет распределения плотности электронных состояний в хвосте зоны проводимости аморфных полупроводников." *«Узбекский физический журнал»* 22.6 (2020): 344-349.
29. IKRAMOV, RUSTAM GULOMJONOVICH, MASHXURA ANVARBEKOVNA NURIDDINOVA, and KHURSHID ADHAMJON UGLI MUMINOV. "Parameters defining the interzonal absorption coefficient in amorphous semiconductors." *Journal of Applied Physical Science International* 12.1 (2021): 36-40.
30. Ikramov, R. G., M. A. Nuriddinova, and R. M. Jalalov. "Density of defect states and spectra of defect absorption in a-Si: H." *Ukrainian journal of physics* 64.4 (2019): 315-315.
31. Ikramov, R. G., M. A. Nuriddinova, and A. Muminov Kh. "Spectra of the coefficient of defect absorption and the energy position of defects in amorphous hydrogenated silicon." *International Journal of Multidisplinary Trends* 1.1 (2019): 12.
32. Zaynobidinov, S., et al. "Infra-red absorption spectra of amorphous semiconductors." *Uzbekiston Fizika Zhurnali* 21.2 (2019): 88-92.
33. Ikramov, R. G., M. A. Nuriddinova, and A. Muminov Kh. "Spectra of the coefficient of defect absorption and the energy position of defects in amorphous hydrogenated silicon." *International Journal of Multidisplinary Trends* 1.1 (2019): 12.
34. ZAYNOBIDINOV, S., et al. "Spectra of interband absorption and optical gap of amorphous semiconductors; Spektry mezhzonnogo pogloshcheniya i opticheskaya shchel'amorfnykh poluprovodnikov." *Uzbekiston Fizika Zhurnali* 15 (2013).
35. Zainobidinov, S., et al. "Distribution of electron density of states in allowed bands and interband absorption in amorphous semiconductors." *Optics and spectroscopy* 110 (2011): 762-766.
36. Zajnobidinov, S., et al. "Dependence of the Urbach energy on the Fermi level in A-Si: H films; Zavisimost'ehnergii Urbakha ot urovnya Fermi v plenkakh a-Si: H." *Ukrayins' kij Fyizichnij Zhurnal (Kyiv)* 53 (2008).
37. Zajnovidinov, S., et al. "Temperature effect in absorption spectra of amorphous semiconductors; Temperaturnyj ehffekt v spektrakh pogloshcheniya amorfnykh poluprovodnikov." *Ukrayins' kij Fyizichnij Zhurnal (Kyiv)* 53 (2008).
38. Qo'chqarov, B. X., A. Nishonov, and X. O. Qochqarov. "Scientific bulletin of Namangan State University,"." *The effect of tunneling gurrent on the spedd surface generation of charge garries* 1.7 (2020): 3-6.
39. Qo'chqarov, Bekzod Xoshimjonovich, Azizbek Nishonov, and Xoshimjon Ortiqovich Qo'chqarov. "The effect of tunneling current on the speed surface generation of charge carriers." *Scientific Bulletin of Namangan State University 2019y* 1.7 (2009): 3-6.
40. Usmanov, P. N., A. I. Vdovin, and A. N. Nishonov. "Investigating the Energies and Electrical Characteristics of the Negative Parity States of the 156Gd Nucleus." *Bulletin of the Russian Academy of Sciences: Physics* 86.8 (2022): 918-923.
41. Усманов, П. Н., et al. "Энергия и структура октупольных состояний ядра 238U." *«Узбекский физический журнал»* 24.2 (2022): 90-95.
42. Arof, A. K., et al. "Investigation on morphology of composite poly (ethylene oxide)-cellulose nanofibers." *Materials Today: Proceedings* 17 (2019): 388-393.
43. Abdukarimov, Abdullaziz, et al. "Characteristics of dye-sensitized solar cells (DSSCs) using liquid and gel polymer electrolytes with tetrapropylammonium salt." *Optical and Quantum Electronics* 52 (2020): 1-15.

44. Abdukarimov, Abdullaziz, et al. "Influence of charge carrier density, mobility and diffusivity on conductivity–temperature dependence in polyethylene oxide–based gel polymer electrolytes." *High Performance Polymers* 34.2 (2022): 232-241.
45. Kuchkarov, B. H., et al. "Influence of all-round compression on formation of the mobile charge in lead-borosilicate glass structure." *American Institute of Physics Conference Series*. Vol. 2432. No. 1. 2022.
46. Uktamaliyev, B. I., et al. "Determination of transport properties for polymer electrolytes containing LiTf and MgTf2 salts." *Molecular Crystals and Liquid Crystals* 763.1 (2023): 17-27.
47. Mamatkarimov, O. O., R. Khamidov, and A. Abdukarimov. "The relative current change, concentration, and carrier mobility in silicon samples doped nickel and at pulse hydrostatic pressure." *Materials Today: Proceedings* 17 (2019): 442-445.
48. Uktamaliyev, B. I., et al. "Determination of transport properties for polymer electrolytes containing LiTf and MgTf2 salts." *Molecular Crystals and Liquid Crystals* 763.1 (2023): 17-27.
49. Abdukarimov, A. A., et al. "Dependence of the characteristics of dye-sensitized solar cells on amount tetrapropylammonium iodide." *«Узбекский физический журнал»* 22.4 (2020): 250-253.
50. Sultanov, A. M., A. A. Abdukarimov, and M. Z. Kufian. "Development of technology for creating high-voltage p0–n0 junctions based on GaAs." *Bulletin of the Karaganda University" Physics Series"* 112.4 (2023): 50-56
51. Abdukarimov, A. A., et al. "Characteristics of natural dye sensitized solar cells." *Molecular Crystals and Liquid Crystals* 767.1 (2023): 98-105.
52. Mamatkarimov, O., B. Uktamaliyev, and A. Abdukarimov. "Temperature dependence of active and reactive impedances of PMMA-EC-LITF2 solid polymer electrolytes." *НАУЧНЫЕ ОСНОВЫ ИСПОЛЬЗОВАНИЯ ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ НОВОГО УРОВНЯ И СОВРЕМЕННЫЕ ПРОБЛЕМЫ АВТОМАТИЗАЦИИ* (2022): 366.
53. Manjuladevi, R., et al. "Preparation and characterization of blend polymer electrolyte film based on poly (vinyl alcohol)-poly (acrylonitrile)/MgCl 2 for energy storage devices." *Ionics* 24 (2018): 1083-1095.
54. Mamatkarimov, O., A. Abdukarimov, and B. Uktamaliev. "ABOUT THE CHARACTERISTICS OF MULTILAYER THIN-FILM STRUCTURES WITH DYES BASED ON TITANIUM DIOXIDE." *Euroasian Journal of Semiconductors Science and Engineering* 3.40 (2021): 26-29.
55. Yakubbaev, A. A., A. Abdukarimov, and S. H. Nazarov. "Application of pincents of spinal leaf (chlorophylle) as a natural die for paint sensitive sun element (DSSC)." *ACADEMICIA: An International Multidisciplinary Research Journal* 11.8 (2021): 185-188.
56. Odiljon, Mamatkarimov, Uktamaliyev Bekzod, and Abdullaziz Abdukarimov. "Determination of ionic conductivity of polymer electrolytes in li-ion batteries using electrochemical impedance spectroscopy." *ACADEMICIA: An International Multidisciplinary Research Journal* 11.7 (2021): 141-146.
57. Mamatkarimov, O., and A. Abdukarimov. "ABOUT THE CHARACTERISTICS OF MULTILAYER THIN-FILM STRUCTURES WITH DYES BASED ON TITANIUM DIOXIDE." *Euroasian Journal of Semiconductors Science and Engineering* 2.3 (2020): 28.
58. Abdukarimov, A. A. "UDK: 621.315. 592 MAIN ELECTROPHYSICAL CHARACTERISTICS OF DYE-SENSITIZED SOLAR CELLS (DSSCS)." *атты V Халықаралық ғылыми-тәжірибелік конференция*.

59. Корольков, В. И., and Александр Владимирович Рожков. "Исследование стабильности переключения высоковольтных субнаносекундных фотонно-инжекционных коммутаторов." *Письма в Журнал технической физики* 18.10 (1992): 26-31.
60. Sultanov, A. M., E. K. Yusupov, and R. G. Rakhimov. "Investigation of the Influence of Technological Factors on High-Voltage p0–n0 Junctions Based on GaAs." (2024).
61. Avrutin, E. A., Korol'Kov, V. I., ORLOV, B., Rozhkov, A. V., & Sultanov, A. M. (1992). Dynamic characteristics of high-power pulses generated in GaAs/AlGaAs superluminescent diodes. *Soviet physics. Semiconductors*, *26*(4), 403-406.
62. Sultanov, A. M., & Mirzarayimov, J. Z. (2024). MAIN TECHNOLOGICAL FACTORS AFFECTING THE PROPERTIES OF LOW-DOPED LAYERS AND TRANSISTOR n+-p0–n0 STRUCTURES. *European Journal of Emerging Technology and Discoveries*, *2*(3), 41-47.
63. Султанов, А. М., and Ж. З. Мирзарайимов. "ОСОБЕННОСТИ И ПЕРСПЕКТИВЫ ИСПОЛЬЗОВАНИЯ ФОТОННОЕ–ИНЖЕКЦИОННЫХ ИМПУЛЬСНЫХ ТИРИСТОРОВ ДЛЯ МОДУЛЯЦИИ УСИЛЕНИЯ ПОЛУПРОВОДНИКОВЫХ ГЕТЕРО ЛАЗЕРОВ." *Multidisciplinary Journal of Science and Technology* 4.3 (2024): 577-583.
64. Рожков, А. В., А. М. Султанов, and Х. Бозоров. "ГЕТЕРОПЕРЕХОДЫ МИКРОЭЛЕКТРОНИКЕ." *И ПРИКЛАДНЫЕ ПРОБЛЕМЫ СОВРЕМЕННОЙ ФИЗИКИ FUNDAMENTAL AND APPLIED PROBLEMS OF MODERN PHYSICS* (2023): 115.