oftob yaxshi tushadigan yuza (10 sm cha chuqurlikka) qatlamiga qo‘yadi. Tuxumining rivojlanishi 9—15 kun davom etadi. Lichinkasi qishlab chiqqach, kelasi yili iyun—iyulda g‘umbakka aylanadi. Yosh qo‘ng‘izlar iyulda ham tuxum qo‘yadi. Lichinkalari ekilgan urug‘larni yeb va o‘simlik ildiz bo‘g‘zini kemirib zarar keltiradi.

Makkajo‘xori simqurti (Agritosmeticulosus Cand.) kattikkanotlilar yoki qo‘ng‘izlar turkumining qirsildoq qo‘ng‘izlar oilasiga mansub hasharot. Asosan, tanasining uz. 7,5— 9,6 mm. Rangi qora. Qanotlari rivojlanmagan, ustki qanotlari birlashib ketgan. Lichinkasi simsimon, ingichka tanali. 2—2,5 mm uzunlikda, sariqyoki qo‘ng‘ir rangli bo‘ladi. Lichinkasining rivojlanishi 3—4 yilgacha davom etadi, yetilgan lichinkalari kuzga borib g‘umbakka aylanadi, undan chiqqan qo‘ng‘izlari qishlab qoladi. Kelgusi yilning kuklami yoki yozida qo‘ng‘izlari tuproq ostidan chiqadi. Urg‘ochisi tuproqning yuza qavatidagi yorikdarga yoki kesaklar tagiga bittabittadan yoki to‘p-to‘p qilib 150 tagacha tuxum qo‘yadi. Tuxumdan 20—40 kunda sariq boshli oq lichinkalar chiqadi. Lichinka o‘sgan sari tanasi sarg‘ayadi. Bu hasharot tuprokda unib kelayotgan urug‘larni va o‘simlik ildizlarini kemirib zararlaydi.

2.Shirin makkajo`xorining so`ruvchi zararkunandalari. Makkajo`xori shirasi (Aphis madiris Fitsch)-**O`rta Osiyo sharoitida makkajo`xori, oq jo`xori hamda makka supurgisiga bir necha tur shiralar zarar yetkazishi mumkin: makkajo`xori shirasi, suli-makkajo`xori shirasi, katta g`alla shirasi, oddiy g`alla shirasi, oddiy g`alla shirasi. Ular teng qanotlilar (Homoptera) turkumiga, shiralar(aphidodea) oilasiga mansubdir. **Tarqalishi.** Bu turlarining barchasi keng tarqalgan. Ular O`rta Osiyodan tashqari Kavkaz va Kavkaz orti, Janubiy va O`rta Yevropa hamda G`arbiy Sibirda uchraydi. **Ta`rifi.** Makkajo`xori shirasining bo`yi 1,6-2,2 mm, tusi yaltiroq, to`q qo`ng`ir rangda, qanotsizlarining mo`ylovi sariq, qanotlilarining mo`ylovi qo`ng`ir tusda. Qanotsiz shiralarning mo`ylovi tanasi bo`yining uchdan bir qismida biroz uzunroq, qanotlilarining mo`ylovi esa tan abo`yining yarmiga teng. Xartumi qisqa. Katta g`alla shirasining kattaligi 2-2,8 mm bo`lib, tusi yashil rangda, qanotlilarining boshi va ko`kragi qizg`ish-qo`ng`ir, xartumining uzunligi tanasi uzunligining uchdan bir to`rtdan bir qismiga to`g`ri keladi, naychasi, mo`ylovi, panjasi, sonining yuqorisi va boldiri qora tusda, mo`ylovi tanasidan uzunroq.Oddiy g`alla shirasining bo`yi 1,2-2 mm, tusi yashil rangda, qanotlilarining boshi, o`rta va keying ko`kragi to`q qo`ng`ir tusda bo`ladi. Mo`ylovi tanasi yarmidan uzunroq. Oldingi qanotining medial tomiri bu shirada bir marta, boshqa hiralarda esa ikki marta shoxlaydi. **Zarari. Shiralarning so`rishi natijasida makkajo`xori va oq jo`xori o`simliklari zararlanadi. O`simliklar o`sish va rivojlanishdan qoladi, barglari sarg`ayadi, ko`p so`talar tugmay, puch bo`lib qoladi, don vazni kamayadi. Shiralar koloniya hosil qilgan o`simliklar 50% gacha don va poya hosilini yo`qotishi mumkin.

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HIGH-TEMPERATURE DIFFUSION OF MANGANESE INTO KDB-3 SILICON: STRUCTURAL AND PLASMONIC EFFECTS

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Abstract. This work investigates the structural, morphological, and plasmonic effects arising from the high-temperature diffusion of manganese into monocrystalline silicon of the

KDB-3 grade. A complex of modern analytical techniques was applied, including X-ray diffraction (XRD), Raman spectroscopy, impedance spectroscopy, scanning electron microscopy with energy-dispersive analysis (SEM/EDS), and BET/DFT porosimetry methods. Experimentally pronounced structural changes were revealed: amorphization, the formation of Mn_5Si_3 and SiB_6 phases, an increase in specific resistivity, and a decrease in charge carrier mobility. Raman spectroscopy and impedance analysis data indicate the manifestation of localized surface plasmon resonance (LSPR) in the range of 40–70 kHz and at 570–600 cm^{-1}. The modified silicon surface is characterized by mesoporosity with dominant pores of 2–5 nm and a specific surface area of up to 23 m^2/g. The obtained results confirm the prospects of Si(KDB-3):Mn for applications in plasmonic sensors, nanophotonics, and spintronics.

The modification of semiconductor materials by introducing transition metals, particularly manganese, is a relevant direction in modern solid-state physics and materials science. High-temperature diffusion of manganese into monocrystalline silicon leads not only to changes in its electrophysical characteristics but also to a profound structural reconstruction, including amorphization, phase formation, and changes in surface morphology. Of particular interest is the possibility of forming localized plasmonic states caused by the collective oscillations of charge carriers near embedded defect complexes and manganese nanoclusters.

Earlier studies demonstrated that such systems might exhibit signs of localized surface plasmon resonance (LSPR), expanding the potential applications of modified silicon in nanophotonics, sensorics, and spintronics. Nevertheless, despite the considerable number of works in this area, questions remain regarding the mechanism of plasmon-active region formation and their relationship with the morphological and phase structure.

The present study aims at a comprehensive investigation of the effects arising in KDB-3 silicon after high-temperature manganese diffusion. The objective is to identify structural, morphological, and plasmonic changes using X-ray structural analysis, Raman and impedance spectroscopy, and porosity analysis via BET/DFT methods.

1. Materials and Methods

Monocrystalline silicon plates of KDB-3 grade with dimensions of 8×4×1 mm and a specific resistivity of about 2.3×10^3 Ω·cm were used as research objects. The doping process was carried out by high-temperature diffusion of manganese in an air atmosphere at 1473 K for one hour. After cooling, the samples underwent multistage analysis to identify changes in structure, composition, and electrophysical properties.

The phase composition was determined by X-ray diffraction (XRD) using a diffractometer with CuKα radiation. Surface morphology was examined by scanning electron microscopy (SEM) combined with energy-dispersive spectroscopy (EDS) to determine local elemental composition. Vibrational spectra were analyzed using Raman spectroscopy, which allowed the identification of characteristic shifts and the appearance of additional bands interpreted as signs of plasmonic effects.

Electrophysical characteristics were investigated by impedance spectroscopy within the frequency range of 1 kHz to 1 MHz. Porosity was determined from nitrogen adsorption/desorption isotherms, with specific surface area and pore distribution calculations based on the Brunauer–Emmett–Teller (BET) method and density functional theory (DFT).

2. Results

As a result of manganese diffusion, a significant increase in the specific resistivity of the samples was observed, indicating a decrease in the concentration and mobility of the primary charge carriers. The average mobility decreased more than fivefold compared to initial values. These data point to substantial distortion of the crystal lattice and the formation of defect complexes blocking charge transport.

X-ray phase analysis revealed the appearance of new phases — SiB_6 and Mn_5Si_3 — as well as pronounced background broadening, indicating the presence of an amorphous component. Scherrer method calculations showed a reduction in average crystallite size to approximately 37 nm, confirming nanostructuring of the material.

Raman spectra recorded a shift of the main peak to lower frequencies, associated with decreased crystallinity and the strengthening of defect modes. The appearance of additional bands in the 570–600 cm^{-1} region suggested the presence of localized plasmonic states arising near manganese nanoinclusions or aggregations.

Impedance spectra demonstrated the presence of resonance features appearing as arc-shaped segments on Nyquist diagrams and phase angle minima in the 40–70 kHz range. These features correlate with known manifestations of plasmonic traces in doped semiconductor structures.

Porosity analysis showed the presence of a well-developed mesoporous structure with most pores in the 2–5 nm range. The total surface area reached 23 m^2/g. Adsorption isotherms corresponded to type IV with characteristic hysteresis, indicating capillary condensation and the presence of open mesopores.

3. Discussion

The obtained results indicate that high-temperature manganese diffusion in KDB-3 silicon is accompanied by a complex restructuring of its structure and properties. The formation of SiB_6 and Mn_5Si_3 phases agrees with findings from recent studies (Wang et al., 2020; Ren et al., 2022), where similar phases were observed in silicon doped with transition metals.

The presence of an amorphous component exceeding 70% may be due to uneven manganese distribution and its aggregation in submicron regions, which also disrupts long-range order. This is supported by both the Raman peak shift and increased background levels in the spectrum.

The emergence of bands in the 570–600 cm^{-1} region in the Raman spectrum and resonance features in impedance diagrams indicates the existence of localized plasmon resonances in the system. Similar effects have previously been recorded in works by Bao et al. (2020), Kobayashi et al. (2019), and others, and interpreted as LSPR responses from metallic and semimetallic clusters embedded in a dielectric matrix.

The development of mesoporosity and increased surface area correlate with morphological changes recorded by SEM. According to Thommes et al. (2019), such porous architecture enhances surface effects, including plasmonic excitations, especially in the presence of metallic centers.

Conclusion

The conducted research demonstrated that manganese implantation in KDB-3 silicon at high temperatures leads to multilevel transformations: from phase and amorphous restructuring to the formation of a mesoporous structure and the emergence of localized plasmonic effects. The obtained results may be applied for developing new functional materials with tunable electrophysical and optical properties.

Modified KDB-3 silicon is of interest for use in sensor platforms, plasmon-optical devices, and spintronic elements. Future research is planned to extend the temperature range of studies and conduct a more detailed analysis of plasmonic states using infrared spectroscopy and photonic correlation measurements.

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BUXORO VILOYATI RELYEFINING IQLIMGA TA’SIRI.

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Iqlimning shakllanishiga ko‘plab tabiiy omillar ta’sir ko‘rsatadi. Ushbu omillar hududning umumiy geografik xususiyatlariga, relyefiga va tabiiy resurslariga chambarchas bog‘liqdir. Asosiy iqlim hosil qiluvchi omillar sifatida joyning geografik o‘rni, dengiz sathidan balandligi, okean oqimlari, quruqlik va suv havzalari taqsimoti, quruqlik yuzasining orografik tuzilishi, shuningdek, yer usti qoplamining holati (o‘simlik, qor va muzliklar)ni keltirish mumkin. Iqlim elementlarining yer yuzida qanday taqsimlanishi, ayniqsa, zonallik xususiyati, eng avvalo geografik o‘rin bilan bog‘liqdir. Masalan, quruqlik va dengizlarning qanday joylashgani iqlim turlarining shakllanishida muhim ahamiyat o‘ynaydi. Aynan shu omil asosida iqlim turlari dengiz iqlimi va kontinental iqlimga ajraladi. Quruqlikdagi relyef shakllari, masalan, tog‘lar va pasttekisliklar esa havo massasining harakati va yog‘in-sochin miqdoriga ta’sir qiladi. Yer yuzasini qoplaydigan o‘simliklar ham iqlimga sezilarli darajada ta’sir ko‘rsatadi. Masalan, zich o‘simlik qoplami tuproq haroratining sutkalik tebranishini kamaytiradi va umumiy haroratni pasaytiradi [1]. O‘simlik, qor va muzlik qoplamining iqlimga ta’siri ko‘proq mikroiqlim doirasida namoyon bo‘ladi, biroq bu omillarning ahamiyati global miqyosda ham inkor etilmaydi. Umuman olganda, iqlim shakllanishi - bu ko‘p qirrali jarayon bo‘lib, u tabiiy geografik omillar majmuasining o‘zaro ta’siri asosida yuzaga keladi.

Buxoro viloyati Yevrosiyo materigining markaziy qismida, O‘zbekiston Respublikasining janubi-g‘arbida, Zarafshon daryosining quyi oqimi va janubi-g‘arbiy Qizilqum cho‘li hududida joylashgan. Uning shimoli-g‘arbiy chegarasi Xorazm viloyati va Qoraqalpog‘iston Respublikasi bilan tutash, shimol va sharq tomondan esa viloyat katta masofada Navoiy viloyati bilan o‘ralgan. Janubi-sharqda Qashqadaryo viloyatining Qarnob va Qarshi cho‘llari bilan qo‘shni, janubi-g‘arbiy qismi esa keng hududda Turkmaniston davlati bilan chegaradoshdir. Buxoro viloyati 1938-yil 15-yanvarda tashkil etilgan bo‘lib, O‘zbekiston Respublikasining dastlabki viloyatlaridan biri sanaladi. Uning umumiy maydoni 40,22 ming km²ni tashkil etadi. 2018-yilda Zafarobod va Ko‘kcha mahalla fuqarolar yig‘inlarining Navoiy viloyati tarkibiga o‘tkazilishi natijasida viloyat maydoni 0,1 ming km²ga kamaygan. Bugungi kunda viloyat O‘zbekiston umumiy yer maydonining 9 foizini egallab, Qoraqalpog‘iston Respublikasi va Navoiy viloyatidan keyingi 3-o‘rinda turadi [2].