RuO_2 NANOZARRACHALARINING LEGIRLANGAN SILIKAT SHISHADAGI HOLATI

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ANNOTATSIYA

Ushbu maqolada 700 K dan yuqori temperaturada Legirlangan slikat shisha (LSSh) ning solishtirma qarshiligi ρ va termoEYuK koeffitsienti S keskin oshib, maksimumga chiqadi va keyin kamayadi. ρ va S ning bunday o’zgarishlari ligaturaning kristall qoldiqlaridagi struktura o’tishlari oqibati bo’lishi mumkinligi taxmin qilindi. Mazkur ishning maqsadi - bu taxminni tajribada sinash. Buning uchun ligaturaning va LSSh ning tuzilishi 300, 773, 993 va 1123 K temperaturalarda rentgen nurlari difraksiyasi yordamida o’rganildi va olingan natijalar tahlil qilindi.

Kalit so‘zlar: qo‘rg‘oshin-silikat shisha, legirlash, ruteniy dioksidi,elementar yacheyka, solishtirma qarshilik, termoEYuK, roentgen nurlari difraksiyasi, nanokristallar, struktura o‘tishlari.

ABSTRACT

In this article, at a temperature above 700 K, the specific resistance ρ and thermoEMF coefficient S of Alloyed silicate glass (LSG) increase sharply, reach a maximum, and then decrease. It was assumed that such changes of ρ and S could be the result of structural transitions in the crystal remains of the ligature. The purpose of this work is to test this assumption in an experiment. For this, the structure of the ligature and LSG was studied using X-ray diffraction at temperatures of 300, 773, 993 and 1123 K and the obtained results were analyzed.

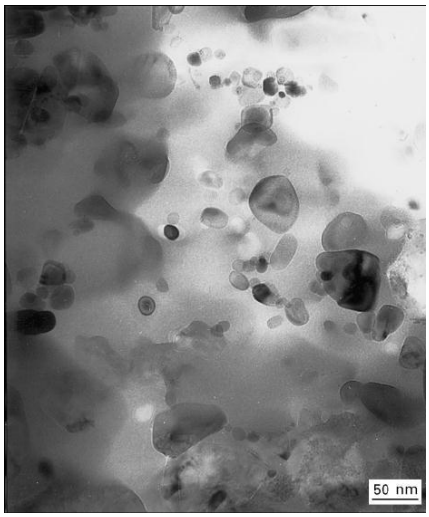
Keywords: lead-silicate glass, alloying, ruthenium dioxide, elementary cell, resistivity, thermoEMF, X-ray diffraction, nanocrystals, structural transitions.

KIRISH

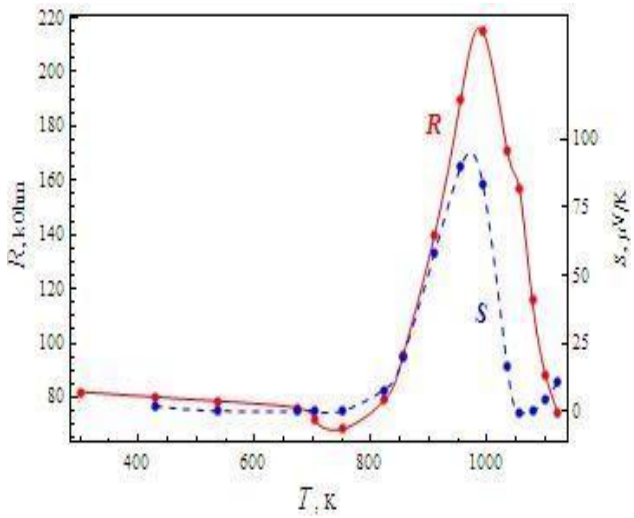
Legirlangan qo’rg’oshin-silikat shisha (LSSh) qalin qatlamli rezistorlar, fizikaviy va kimyoviy ta’sirlar datchiklari hamda elektr isitgichlar sifatida uzoq yillar davomida keng qo’llanib kelayapti. Shunga qaramasdan LSSh ning hali o’rganilmagan jihatlari bor. Masalan, silikat shishani legirlaganda ligaturazarrachalari shishaning ichida qisman kristall

holida qolib ketadi (1-rasm) [1]. Adabiyotlarda bu qoldiq kristallar zaryad tashuvchilarning lokallashuvi markazlari bo'ladi va LSSh ning elektr o'tkazuvchanligi Mott mexanizmi (o'zgaruvchan masofaga sakrash) orqali bo'ladi, - degan faraz ko'p muhokama qilindi [2], ammo tajribada tasdiqlanmadi.

Ikkinchi tomondan, 700 K dan yuqori temperaturada LSSh ning solishtirma qarshiligi ρ va termoEYuK koeffitsienti S keskin oshib, maksimumga chiqadi va keyin kamayadi (2-rasm) [3]. ρ va S ning bunday o'zgarishlari ligaturaning kristall qoldiqlaridagi struktura o'tishlari oqibati bo'lishi mumkinligi taxmin qilindi. Mazkur ishning maqsadi - bu taxminni tajribada sinash. Buning uchun ligaturaning va LSSh ning tuzilishi 2-rasmdagi xos temperaturalar – 300, 773, 993 va 1123 Kda rentgen nurlari difraksiyasi yordamida o'rganildi.



1-rasm. Legirlangan silikatshisha tuzilishining elektron mikroskopdagi tasviri



2-rasm.RuO_2 bilan legirlangan $2SiO_2 \cdot PbO$tarkibli shishada solishtirma qarshilik ρ va termoEYuK koeffitsienti S ning temperaturabo'ylab o'zgarishi [3].

ADABIYOTLAR TAHLILI VA METODOLOGIYA

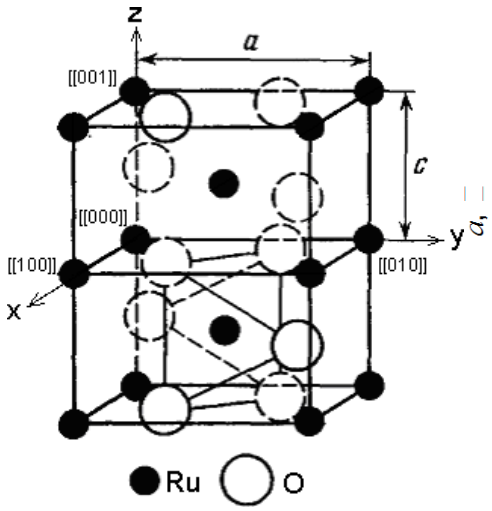
Silikat shishani legirlashda ko'p ishlatiladigan eng oddiy ligatura RuO_2 bo'lib, uning kimyoviy va fizikaviy xossalari ancha keng o'rganilgan [3]. RuO_2 ning elementar yacheykasi rutil turida (tetragonal) bo'lib (3-rasm), uning parametrlari

1-jadvalda keltirilgan [3], issiqlikdan kengayish koeffitsienti (IKK $\alpha = (\Delta L/L)/\Delta T$) anizotropik (xona temperaturasida a o'qi yo'nalishida $+140 \cdot 10^{-7}$ K^{-1}, c yo'nalishida $-32 \cdot 10^{-7}$ K^{-1}), ammo monoton emas (4-rasm) [4], va $2SiO_2 \cdot PbO$ tarkibli shishaning izotropik koeffitsienti ($70 \cdot 10^{-7}$ K^{-1}) dan ancha farq qiladi.

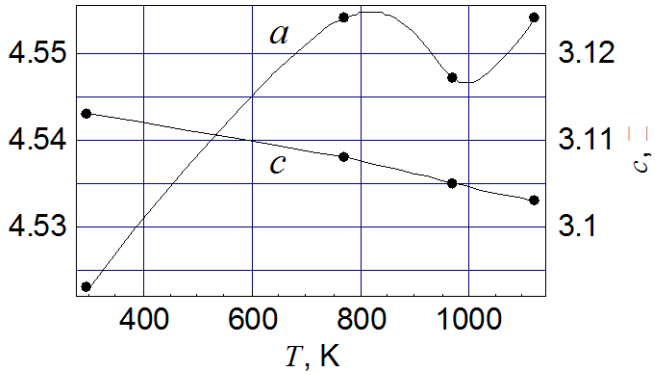
1-jadval

RuO2 ning elementar yacheykasi o'lchamlari		
Yacheyka o'lchami, Å		
a = b	c	a/c
4,51±0,02	3,11±0,02	0,690

RuO_2 ning yana bir o'ziga xos jihati – yumshoqligi – Young moduli 24-27,5 GPa [5, 6], holbuki silikat shishada bu xossa 48-83 GPa [7].



3-rasm.RuO_2 ning elementar yacheykasi



*4-rasm.RuO_2 kukunlarining issiqlikdan kengayish koeffitsientining **a** va **c** yo'nalishlarida temperatura bo'ylab o'zgarishi*

Masalaning yana bir jihati shunda-ki, odatda ligaturaning hajmi shishaninghajmidan bir necha marta kam bo'ladi. Shunga ko'ra LSSh ning ichida RuO_2 qoldiqlariga shishaning mexanik ta'siri ostida bu qoldiqlar deformatsiyalangan (a yo'nalishda siqilgan, c yo'nalishda cho'zilgan) bo'lishi lozim. Ammo bu mavzuda adabiyotlarda ma'lumot yo'q, shu sababdan RuO_2 qoldiqlarining shisha ichidagi holati tajribada aniqlash lozim.

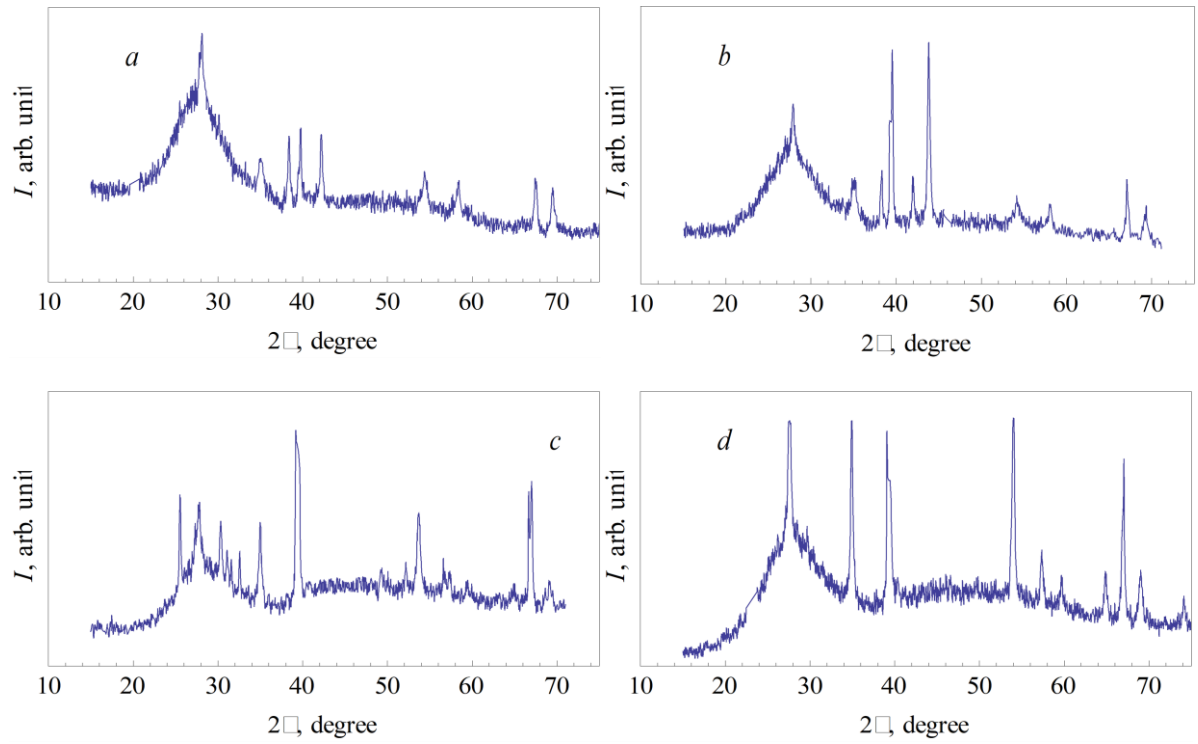
NATIJALAR

Yuqorida biz legirlangan silikat shishada ligatura zarrachalarining kristal qoldig'i bo'lishi va bu qoldiqning issiqlikdan kengayish koeffitsienti (IKK) shishanikidan farq qilishi tufayli zarrachalar deformatsiyalangan holatda bo'lishi lozimligini ko'rsatilgan. Bu keltirilgan fikrlarni isbotlash uchun RuO_2 bilan (10 vazn %) legirlangan $2SiO_2 \cdot PbO$ (massasi bo'yicha 33 % SiO_2 , 67 % PbO) tarkibli shisha kukunlarida 300, 773, 973 va 1123 K temperaturalarda rentgen nurlarining difraksiyasini o'rgandik (5-rasm). Rentgenogrammalar O'zbekiston geologiya va mineral resurslar komitetining Mineral

resurslar institutida Simens firmasining D500 rentgen difraktometrida Anton Paar HTK16N yuqori temperatura kamerasida olindi.

$$\frac{1}{d_{hkl}^2} = \frac{h^2 + k^2}{a^2} + \frac{l^2}{c^2}$$

2-jadvalda rentgenogrammalardagi RuO_2 ga xos bo'lgan asosiy maksimumlarning joylashuvi va nisbiy intensivligi va taqqoslash uchun RuO_2 monokristallarining ASTM (21-1172) kartotekasidan olingan xos chiziqlari keltirilgan. RuO_2 ning tetragonal elementar yacheykasi parametrlari a = b va c tekisliklar aro masofa d_{hkl} dan [2] da keltirilgan formula orqali hisoblandi (6-rasm). Bunda biz rentgenogrammalardagi eng intensivligi katta kristallografik tekisliklarga mos maksimumlardan foydalandik.

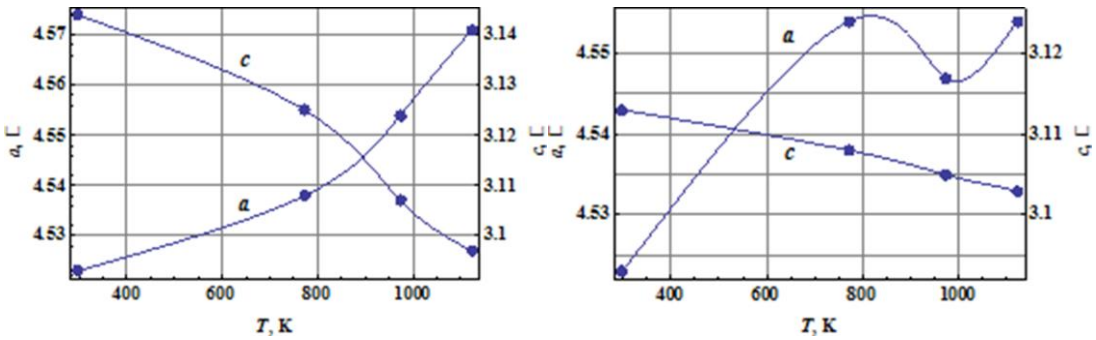


5-rasm. RuO_2 bilan legirlangan $2SiO_2 \cdot PbO$ tarkibli shishada rentgen nurlari sochilishining turli temperaturalardagi (K) tasviri:293 (a), 773 (b), 973 (c) va 1123 (d

6-rasmning a) va b) ni solishtirganda ko'ramizki, legirlangan shisha tarkibidagi ligatura nanozarrachalarining IKK si keskin o'zgargan: a yo'nalishida elementar yacheyka kengayishi monoton tusga kirdi, c yo'nalishida IKK deyarli 2,5 baravar oshdi.

2-jadval.

RuO_2 monokristallarining ASTM (21-1172) kartotekasidagi chiziqlari									
d, Å	**3,17**	**2,550**	2,245	2,17	2,05	**1,685**	1,586	1,552	1,420
I/I_0	**100**	50	10	4	1	30	9	4	5
hkl	110	101	200	111	210	211	220	002	310
Izoh. Birinchi satrda ASTM (21-1172) bo'yicha eng intensiv maksimumlar ajratilgan									

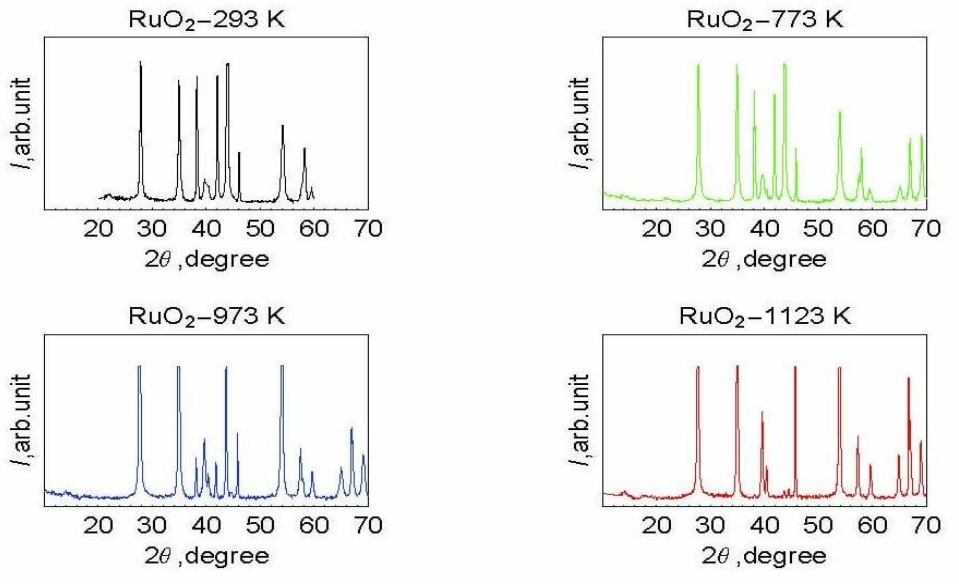


a) *b)*

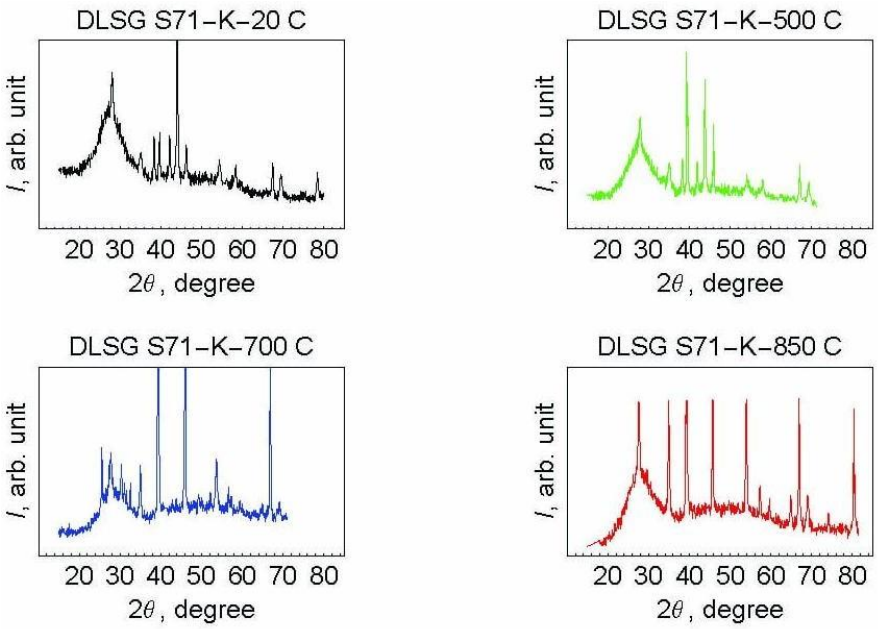
6-rasm. Erkin RuO2 (a) va RuO2 bilan legirlangan S71-K shishaning panjara konstantalarining haroratga bog'liqligi (b)

MUHOKAMA

Ma'lumki, siqilish deformatsiyasida yarim o'tkazgichlar va metallarning o'tkazuvchanligi ortadi. Shuning uchun, legirlangan silikat shishaning o'tkazuvchanligi, agar u bir-biri bilan bevosita aloqada bo'lgan RuO2 zarralaridan iborat cheksiz klaster bo'ylab 800K<T<1123 K temperatura oralig`ida amalga oshirilgan bo'lsa, haroratning oshishi bilan o'q bo'ylab birlik panjara doimiysining pasayishi kuzatiladi. Demak, Shisha va $RuO_2$ ning issiqlikdan kengayish koeffitsientlarining farqi legirlangan shishadagi $RuO_2$ qoldiq zarrachalariga kuchli mexanik ta'sir ko`rsatadi.



7a-rasm. Erkin RuO_2 ning rengenogrammalari



7b-rasm. RuO2 bilan legirlangan S71-K shishaning rengenogrammasi

Yuqoridagi erkin RuO_2 ning rengenogrammalari hamda RuO_2 bilan legirlangan S71-K shishaning rengenogrammasida bir biridan sezilarli farq qiladigan spektrlarni ko'rishimiz mumkin.

XULOSA

RuO_2 nanozarrachalarining legirlangan silikat shishadagi holatini o`rganishda rentgen nurlar difraksiyasi yordamida olingan natijalar orqali taxlil qilindi. Bunda legirlangan shisha tarkibidagi

ligatura nanozarrachalarining Issiqlikdan kengayish koefitsienti (IKK) keskin o'zgargan: 1) a yo'nalishida elementar yacheyka kengayishi monoton tusga kirdi; 2) c yo'nalishida IKK deyarli 2,5 baravar oshdi. RuO_2 bilan legirlangan $2SiO_2 \cdot PbO$ tarkibli shishada solishtirma qarshilik ρ va termoEYuK koeffitsienti S ning temperatura bo'ylab o'zgarishi hamda uning rentgen nurlari sochilishining turli temperaturalardagi (293 ,773 , 973 va 1123 K) rengennogrammalari olindi.

Erkin RuO2 va RuO2 bilan legirlangan S71-K shishaning panjara konstantalarining haroratga bog'liqligi o`rganildi. Shisha va $RuO_2$ ning issiqlikdan kengayish koeffitsientlarining farqi legirlangan shishadagi $RuO_2$ qoldiq zarrachalariga kuchli mexanik ta'sir ko`rsatadi.

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