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STRUCTURAL PROPERTIES OF SENSOR DEVICE BASED ON MO-SI SYSTEM

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Abstract
Magnetron-ion sputtering through environment inert gas at room temperature in the atmosphere Czochralski method with cultivated silicon monocrystalline 1-2 microns on the surface thick molybdenum metal layer laid down. Thermal from annealing then, Mo atoms silicon monocrystalline deep molybdenum silicide alloy harvest This will do. at work this silicides morphology, structure and features studied.

Keywords: Magnetron sputtering, silicon, metal, semiconductor, silicide, morphology, phase, structure.

1. Introduction

Molybdenum, other to the fire-resistant metals like, unique physicist, mechanic and chemical features package with separated it stands, this his/her different in the fields wide application provided. $MoSi_2$ layer molybdenum on top silicide of the coating to the heat endurance and to the heat endurance noticeable at the level increases, metals , such as chromium and iron with Soldered [1-3]. Temperature 1300 ÷ 1450°C between of coatings high to the heat endurance continuous glassy silicon dioxide of the film harvest to be with related is , then little in quantity alloy elements there is when it is , to the unsoldered relatively more melts , big to liquid have , produce was defects to correct capable and product temperature sharp change during thermal of voltages softening makes it easier . Work temperature increase with diffusion in size molybdenum silicide combination molybdenum disilicide to metal diffuse within reach dominant factor is [4].

$MoSi_2$ disilicide structure in learning molybdenum-silicon in the system X-ray rays determined and later Mo^3Si and MoSi 0.65 compounds found .

The state of Mo-Si balance phase to the diagram according to , molybdenum silicon with refractory silicide harvest does (Figure 1), this in the system three compound available : molybdenum disilicide $MoSi_2$, lower molybdenum silicides Mo_5Si_3 and Mo_3Si [5,6]. Solid in molybdenum silicon The solubility is 3.35 at. % at 1820 oC and

9 at. % at 2025 °C . organization It is used to make the compound Mo_3Si. based hard solutions field almost no.

2. Experience

Substrate as at least 99.9% pure , 5×12 mm in size and 1.5 mm thick p- and n- type silicon monocrystalline used . From covering before silicon substrate surface distilled in the water diluted polyrite and rectified spirit mixture with cambric cloth with cleaned . Current at the time both in our country and abroad new in other countries abrasive compositions , series and zirconium dioxides taken polyrites , also silicon and aluminum oxides based ready suspensions wide are being used [7,8]. Substrates work to the camera after loading then , silicon monocrystalline of substrates surface 5% oxygen amount in an argon atmosphere high voltage ion source using again worked .

Target as pure molybdenum The metal Mo is used . Obtained metal layer physicist thickness interference extreme with measured hh = $\lambda_0/4$ optical thickness based on calculating It turned out that 1÷2 μm what organization reached The film deposition rate (nm/min) was determined based on the obtained physical thickness and coating time.

Then , Mo metal with covered to the surface has silicon monocrystals in a vacuum quartz in ampoules different at temperatures thermal to hardening X - ray analysis at the Mo-Si boundary and diffuse silicon layer main in part different kind molybdenum silicides compounds harvest to be determined .

silicides interstitial to phases does not enter , because big silicon atoms metal fences into the holes introduction possible not . Silicon atoms metal atoms replaces and to graphite similar networks in the form of complicated crystalline structures harvest Silicides metal atoms and silicon atoms layers much sharp to divorce has layered structures with described, this and shift deformation facilitates and high at temperatures to slip resistance reduces.

3. Results discussion

Modern thermodynamic calculations this shows that in the liquid mixing enthalpy very negative . [9] The authors of the Mo_3Si and Mo_5Si_3 The eutectic occurs at 2020 °C and 26.4 % Si . to be they found out and also, intermediate phase MoSi2 is polymorphic at 1900 °C to transformation meet It was also found that at 1850 °C , $MoSi_2$, Mo_5Si_3 and $MoSi_2$ with the participation of reaction to the existence hint did this and evaluators by is considered speculative and additional to study demand does .

In the system three eutectic there is :

- Mo_3Si - Mo_5Si_3 at 26.4. % silicon and 2020 °C temperature;
- Mo_5Si_3 – $MoSi_2$ in 54. % silicon and a temperature of 1900 °C ;
- $MoSi_2$ – Si 98.5 at. % silicon and at a temperature of 1400 °C.

$MoSi_2$ at temperature C eutectoid there is β. $\leftrightarrow Mo_5Si_3 + \alpha MoSi_2$ and peritectic at 1900 °C $\beta MoSi_2 + P \leftrightarrow \alpha MoSi_2$.

Mo_3Si silicide at 2025 ± 20 ° C Mo + Si = Mo_3Si peritectic reaction as a result harvest will be and a = 0.4890 ± 0.0002 per period has cubic to the structure has (Fig.2).Mo_3Si has a structure of the closest cubic packing type or a type close to it. The large compactness of the lattice emphasizes the metallic nature of the Mo-Si bond, but covalent bonds also exist between the metal atoms in the phases.Mo_5Si_3 silicide melting point 2180 ±at 20 °C equal to , at 1700 °C one diversity of the region width % silicon from 37 to 40.35 .

The compound $MoSi_2$ melts at 2020 ± 20 °C , a diversity range from 65.8 to 66.7 % silicon , tetragonal structure has. $MoSi_2$ of one diversity field one how many percentage organizations to do possible and siliconization temperature increase with increasing goes. Elements in concentration differences as follows : for Si = 2.52 ±0.5%; for Mo = 2 ±0.5 % . $MoSi_2$ silicide Temperature 1850÷1900 °C between allotropic to change Low temperature variety α- MoSi2 tetragonal structure has . High βwith temperature form - MoSi2 to the parameters has six angular to the structure has : a = 0.4642 ± 0.0005, c = 0.6529 ± 0.0005 nm, c/a - 1.406. $MoSi_2$ on the Mo side of the border located 67.1 ± 1.0% (at.). $MoSi_2$ low temperature The shape is made of 2 Mo and 4 Si atoms. consists of is αa tetragonal cell . Si atoms with Mo in the voids frame harvest The structure is parallel to the (010) plane , the most close six angular to wrap has from layers to consider as consisting of possible . The layers are in the order ABAB... alternately stands , layer . BX axis direction by a/ 2 moves . The most short Mo-Si distance c/3. Silicon atoms chains are made of Mo prisms parallel to the X and Y axes transient zigzags harvest does .

Received the results standard X-ray diffraction set of patterns (ASTM) [12] with Comparison of Mo-Si structure the composition determination opportunity Figure 3 shows the structure of Mo-Si. X-ray diffraction patterns The structure is shown . fence parameters by formula is considered .

$$d^2 = \frac{a^2}{\hbar^2+k^2+l^2} = \frac{a^2}{N} \qquad (1)$$

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and Wulf -Bragg formula :

$$\mathrm{Sin}\theta = \frac{\pi}{2a}\mathrm{N} \qquad (2)$$

this on the ground , θ- x-ray from the rays determined Bragg angle - $\mathrm{N} = \hbar^2 + \mathrm{k}^2 + \mathrm{l}^2$ Miller indices. X-rays are absorbed by molybdenum MoSi2 and silicon SiO_2 elementary components characteristic peaks shows, they $_3$ - in the picture shown. During the diffusion process, silicon is partially oxidized by residual oxygen, resulting in the formation of a single-crystal structure and phase - crystallization and recrystallization. Adjacent grains of the crystalline substance form a common boundary.

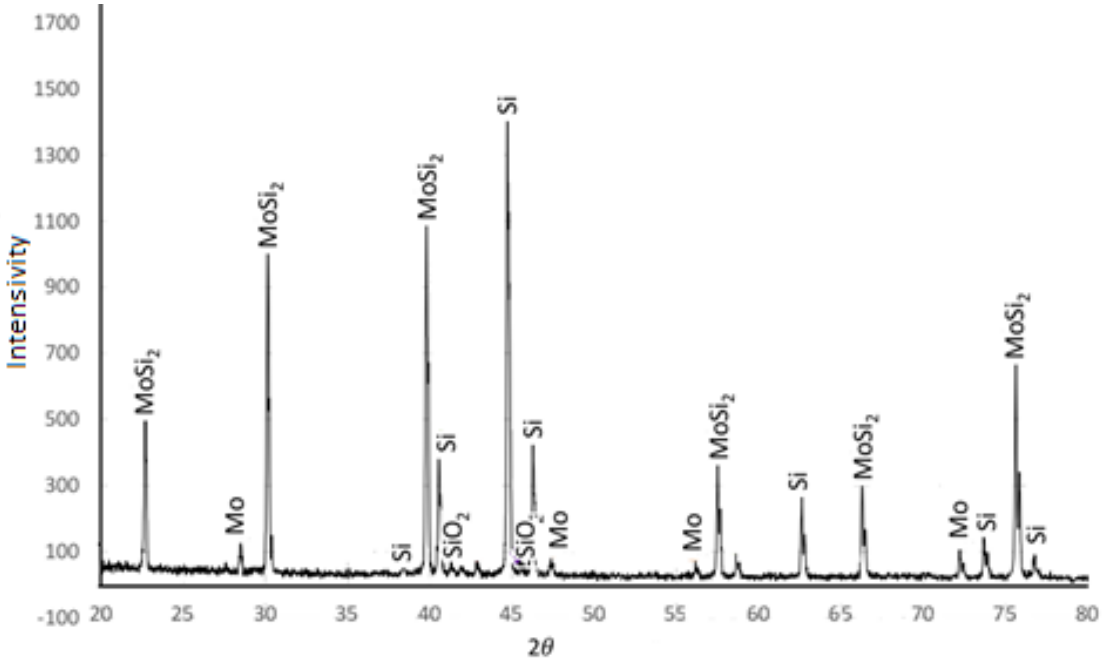

Figure 1 . Bragg-Brentano focusing with Mo-Si copper anode structure diffraction patterns .

Intergranular contact expands and the process of grain coalescence develops. X-ray diffraction analysis of the obtained samples shows a uniform distribution of molybdenum disilicide grains throughout the entire volume of the soldered layer.

The outputs of the chains are directed towards each other, the distances between the Si atoms in the outputs and in the chains are equal, that is, a three-dimensional silicon framework is created. Top with temperature form - βMoSi $_2$ six angular to the structure has (Table 1). They are the Fermi level valence to the lane until it reaches complete bent.

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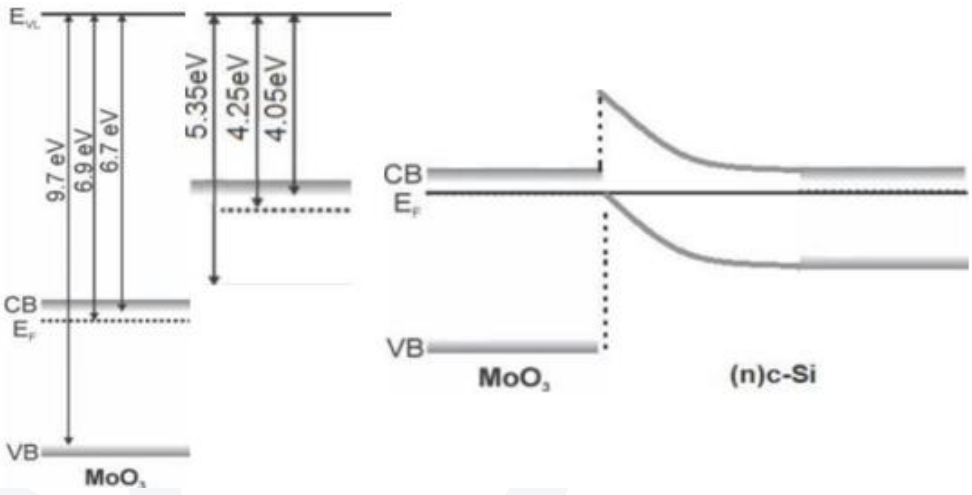
Table 1. Molybdenum silicides crystal-chemical features

Complex	Syngonium	Lattice parameters, nm			c/o	X-ray density g/ cm³
		a	b	c		
Mo_3Si	Cube	0.4890	-	-		8.968
Du_5Si_3	Six angular	0.728	-	0.500	0.69	8.243
Du_5Si_3	Tetragonal	0.9642	-	0.495	0.5087	8.213
α-$MoSi_2$	Tetragonal	0.3203	-	0.7855	2.452	6.267
β- $MoSi_2$	Six angular	0.4642	-	0.6529	1.406	6.26

We are moving. happened from being before , Fermi energy degrees between The difference was 100%. situation imagination let's do Both materials are residual . of energy existence shows , this crystal of the line energy . It is a crystal to the structure has . Offer made answer is that metal oxides such as surface charge density available . Polyimide (MOS) residue to energy proportional [4].



a) b)

Figure 12. Crystal Zone diagram of the pn junction of silicon : a) insulation status and b) from connection compound harvest to be

4. Conclusions

Silicon on the surface from thicker Mo coatings use necessary the results does not give, because metal thickness increase with structure transition in the layer cracks appearance will be. Constructions service to do the deadline to shorten . to cut . to cut layers create through coating and basis between at the border incoming diffuse processes noticeable at the level slow down possible . Diffusion inhibition diffusion element many component compounds harvest when observed.

Molybdenum products from oxidation protection to do promising direction every one layer known one function doer composite many layered coatings is to create - to heat endurance provides, coating basis with parasite mutual the impact prevent takes; in the cover voltages to soften help gives , in the system declines flattens .
Protection silicide molybdenum components features study monocrystals protection characteristics deterioration starting main factors formation opportunity gave , this their oxidizing in the atmosphere high with temperature work during heat stability and coatings provides .

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