PACS: 61.50.Ks

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$ZnAs_2$ ELECTRICAL CONDUCTIVITY AT CYCLIC PRESSURE TREATMENT IN THE 22–50 GPa RANGE

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The aim of the work is to investigate $ZnAs_2$ electrical conductivity at cyclic pressure treatment in the range of 20–50 GPa, to determine concrete values of pressure, at which the changes take place in this material, and to reveal peculiarities of behaviour at pressures up to 50 GPa.

Introduction

$ZnAs_2$ is a compound belonging to semiconductors of $A^{II}B^{V}$ group, their structure peculiarity is chemical bonds between As atoms adjacent to the Zn–As bonds. It is the reason of anisotropy of electrical and optical properties of this material.

The phase transition was found [1] in structurally similar material $CdAs_2$ during studying the hydrostatic compression (0–9 GPa) effect. The similar transition was not found in $ZnAs_2$ at such pressures. That is why we studied this compound at pressures up to 50 GPa, it was shown [2] that irreversible structural changes take place at pressures of 35–40 GPa.

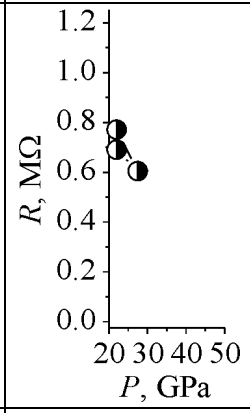
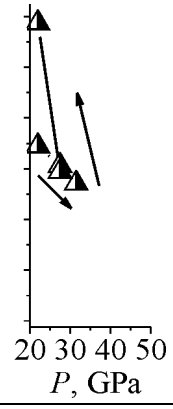
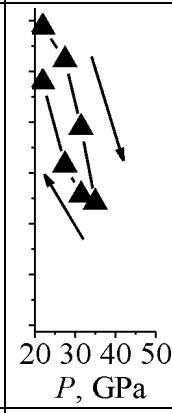
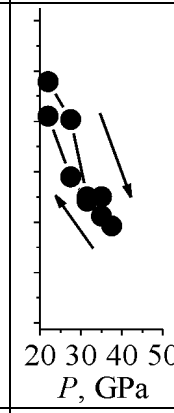
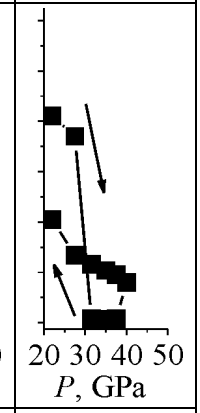
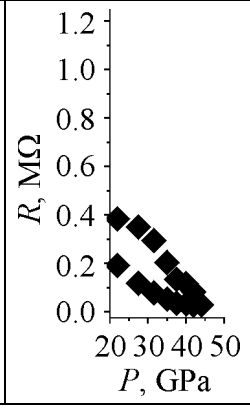
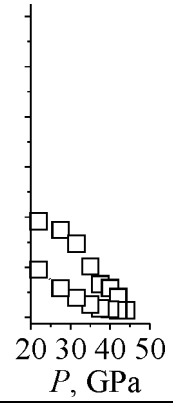
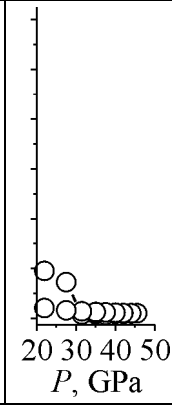
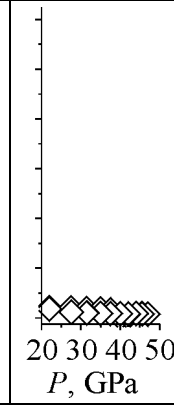
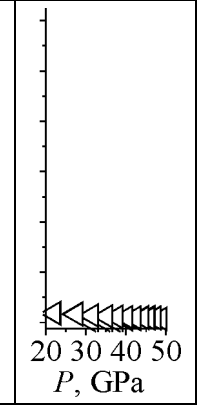
It is interesting to investigate the $ZnAs_2$ electrical conductivity behaviour at cyclic pressure treatment to define more precisely the value of pressure at which the changes take place.

Experimental details

A sample of the material, which was not earlier affected by high pressure, was placed into a diamond anvils cell (DAC) where the initial pressure equal to 22 GPa was generated. Next, the cyclic pressure treatment of the sample was performed, characterized by sequential pressure increasing up to some maximal value and decreasing down to the initial one of 22 GPa. The pressure cycles and corresponding plots of electrical conductivity dependences on pressure for $ZnAs_2$ are shown in the Table 1.

Table

$ZnAs_2$ electrical conductivity pressure dependences at cyclic pressure treatment

№	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5
P_{max}	27.5	31.5	35	37.5	40
Electrical conductivity dependences on pressure					
№	Cycle 6	Cycle 7	Cycle 8	Cycle 9	Cycle 10
P_{max}	42	44	45.5	47	48.5
Electrical conductivity dependences on pressure					

The pressures up to 50 GPa were generated with the help of DAC with «rounded cone-plane» type anvils [3] made from synthetic polycrystalline diamonds «carbonado». The measurements were made at room temperature on the same samples as were used in article [2].

Results and discussion

$ZnAs_2$ resistance values are lower during increasing pressure up to 3.5 GPa than those during pressure decrease, as seen from Table 1. The resistance values are higher during increasing pressure in all other cycles. The $ZnAs_2$ electrical resistance takes the values of about 10^6 Ω at pressures up to 37.5 GPa, however resistance values decrease by the order of magnitude during pressure removal in the 5-th cycle.

The electrical resistance doesn't take the initial values during the next steps of increasing pressure, meaning that the irreversible changes are taking place in this sample. Thus, the obtained result indicates that the pressure value in the interval of 35–40 GPa is a point of irreversible change of $ZnAs_2$ electrical conductivity.

The electrical resistance of the sample once again decreases by the order of magnitude during pressure increase up to 45.5 GPa. This change also remains irreversible that indicates the existence of the second point of irreversible changes of electrical conductivity at a pressure ~ 45.5 GPa.

Conclusion

Investigation of $ZnAs_2$ electrical conductivity at cyclic pressure treatment in the range of 22–50 GPa has shown that two points of irreversible changes exist in this material. The first point, fixed in our previous investigation, is a pressure value equal to 37.5 GPa and the second one equals 45.5 GPa.

1. *A.Y. Mollaev, L.A. Saypulaeva, R.K. Arslanov, S.F. Marenkin*, Neorganicheskie materialy **37**, **4**, 405 (2001) (in Russian).
2. *A.Y. Mollaev, R.K. Arslanov, L.A. Saypulaeva, A.N. Babushkin, T.S. Lyach, S.V. Tatur, S.F. Marenkin, S.G. Michailov*, Fizika i Tekhnika Vysokikh Davlenii **15**, № 1, 102 (2005) (in Russian).
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