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TRIPLE SYSTEM Ge-Sm-Te

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ABSTRACT: By methods of physical-chemical analysis the surface projection of liquidus of triple system Ge-Sm-Te was plotted on base of investigated internal sections: GeTe-Sm_2Se_3, SmTe-Sm_5Ge_3, GeTe-SmTe, $Ge_{080}Te_{020}$- $Sm_{080}Te_{020}$, $Ge_{080}Te_{026}$- $Sm_5Ge_2Te_7$. The peritectic compound $Sm_5Ge_2Te_7$ was found in triple system. Crystallization fields of phases were determined, and coordinates of non-variant points, as well as the reaction, which proceeds in triple system Ge-Sm-Te, was defined.

Key words: physical-chemical analysis, triple system Ge-Sm-Te

INTRODUCTION

Recently the study of complex chalcogenide system with the participation of rare earth elements has attracted the attention of researchers. The present investigation was devoted to physical-chemical research of interaction in Ge-Sm-Te system. Double systems, which form triple system, were studied in detail (Abrikosov N.Kh., Shelimova L.E.,1975, Lyakisheva M., 1997; Lyakisheva M., 2001).

System Ge-Te One GeTe compound exists in Ge-Te system. It was established, that monotelluride of germanium melts congruently at 996 K. The temperature of eutectic between monotelluride of germanium and germanium is 993 K and content 49,85 at % of TeGeTe crystallizes in cubic syngony of type NaCl by period of lattice: a=6.01 Å (Korjuev M.A., 1986).

System Sm-Te Eight compounds were found in the system. Only SmTe compound melts congruently at 1850^{0}C. Sm-Te has zone of homogeneity for 46-50 % (at) Te. Compounds Sm_3Te_4, Sm_2Te_3, Sm_3Te_7, Sm_2Te_5 and $SmTe_3$ are formed by peritectic reactions at 1690, 1500, 890, 830 and 465^{0}C correspondingly (Lyakisheva M., 2001). Two eutectic equilibriums were found in system:

L+Sm+SmTe (980^{0}C), L+Te+$SmTe_3$ (445^{0}C)

Compound SmTe crystallizes in cubic syngony of NaCl type by period of lattice a=0,693Å (Aliyev O.M., Kurbanov T.Kh., Mukhtarova Z.M., System Sm-Ge-Te , 1986).

System Ge-Sm Five compounds were found in system. Ge_3Sm_5 compound melts congruently at 1700^{0}C. Ge_4Sm_5, GeSm, $Ge_{3-4}Sm$, $Ge_{1,56}Sm_{1,04}$ compounds are peritectic (Yeremenko E.H., Batalin V.T., Buyanov, 1977; Tharp A.G., Smith G.S., Johnson Q.1966). State diagram of Ge-Sm system was plotted. The formation reaction of peritectic compounds, eutectic reactions, as well as reactions of polymorph transformations of $Ge_{1,56}Sm_{1,04}$ were investigated.

MATERIALS AND METHODS

For preparation of alloys germanium - Ge-B4, Sm-sm M-1 and telluride- B4, which were treated by sevenfold crystallization, were taken. Samples were melted in sealed 10Pa quartz ampule, which was preliminarily pumped out till residual pressure.The interaction character was defined by methods of differential thermal analysis (DTA), X-ray diffraction and microstructural (MSA) analysis, by measuring micro hardness and density of alloys in the investigated sections of triple system Ge-Sm-Te. Triangulation of system Ge-Sm-Te was carried out beforehand. It was established, that it is divided into four secondary triple systems (Fig.1), limited by quasi-binary sections GeTe-SmTe, SmTe-Sm_5Ge_3, GeTe-Sm_5Ge_3.

Ge- GeTe- Sm_5Ge_3 ; GeTe- SmTe- Sm_5Ge_3; SmTe- Sm- Sm_5Ge_3; GeTe- Te- SmTe.

Chemical interaction by separate sections is the following:

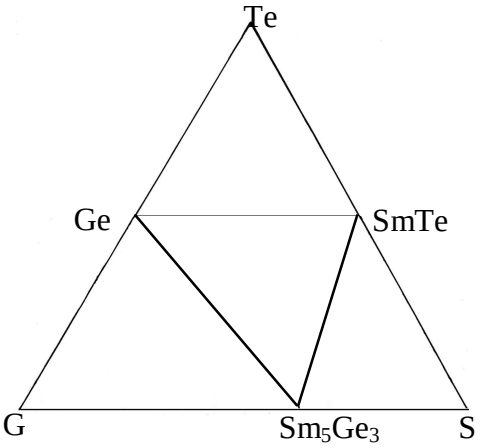

Figure 1. Triangulation of triple system Ge-Sm-Te.

Section GeTe- Sm_2Ge_3 is an eutectic systes. Eutectic corresponds to the content 80% of GeTe and 940 K temperature. Homogeneity zone of GeTe side is 2 mol %, but from Sm_5Ge_3 side it makes 3 mol%.

Section SmTe-Sm_5Ge_3 State diagram is eutectic. Eutectic corresponds to 1650 K temperature and content 52 mol % of SmTe. Solid solutions is 5 mol % on base of SmTe.

Section GeTe- SmTe is quasi-binary section of triple system Sm-Ge-Te. The formation of incongruently melted compound of $Sm_5Ge_2Te_7$ composition was determined in this system. Formation of new phase in system Sm-Te-Ge-Te was confirmed by X-ray diffraction analysis. Zone of solid solutions is 3 mol % SmTe on base of GeTe (Aliyev O.M., Kurbanov T. Kh., Mukhtarova Z.M., 1986).

Non-quasi binary polythermal sections were investigated with the aim to define coordinates of triple non-variant points.

Section $Ge_{0,80}Te_{0,20}$-$Sm_{0,80}Te_{0,20}$ crosses three secondary subordinate systems: SmTe-Sm-Sm_2Ge_3, SmTe-GeTe-Sm_5Ge_3, GeTe-Sm_5Ge_3-Ge. Six zones of primary crystallization y (SmTe), β(Sm_5Ge_3), Sm_5Ge_4, SmGe, $SmGe_{1,5}$Ge were observed in liquidus of system.

Section $Ge_{0,84}Te_{0,16}$-$Sm_5Ge_2Te_7$ is non-quasi binary section of triple system Ge-Sm-Te since it crosses two secondary triple systems GeTe-Ge-Sm_5Ge_3 and GeTe-Sm_5Ge_3-SmTe. Four zones of primary crystallization: L+$SmGe_{1,5}$; L+SmGe; L+Sm_5Ge_7; L+Sm_5Ge_3 were found in liquidus of the system.

Section α (GeTe)-Sm The section α(GeTe)-Sm is non-quasi binary section of triple system Ge-Sm-Te, which crosses two pseudo triple systems: GeTe-Sm_5Ge_3-SmTe (1) and SmTe-Sm_5Ge_3-Sm (2).

Liquidus consists of primary crystallization: L+Sm, L+γ(SmTe), L+β(Sm_5Ge_3), L+Sm, L+α(GeTe). In the first sub system alloys crystallize at 1120 K temperature of triple eutectic. In the second sub system alloys crystallize at 960 K temperature of triple peritectic.

RESULTS AND DISCUSSION

According to physical-chemical investigation of above-mentioned sections, the surface projection of liquidus of triple system Ge-Sm-Te was plotted (Fig.2).

In the system there is crystallization area of 9 zones, 5 of them are in balance with zones of Sm_5Ge_3 compound.

Crystallization zones of SmTe and Sm_5Ge_3 melt tightly. Temperature of alloys in sections GeTe-SmTe, GeTe-Sm_5Ge_3, GeTe-Sm gradually decreases from SmTe, Sm_5Ge_3, Sm to GeTe correspondingly. Crystallization zone of germanium is extended along Ge-Te side. Crystallization zone of samarium is in corner of Sm. Crystallization zone of germanium

telluride has small zone between the zone of germanium and zone of peritectic compound of $Sm_5Ge_7Te_7$.

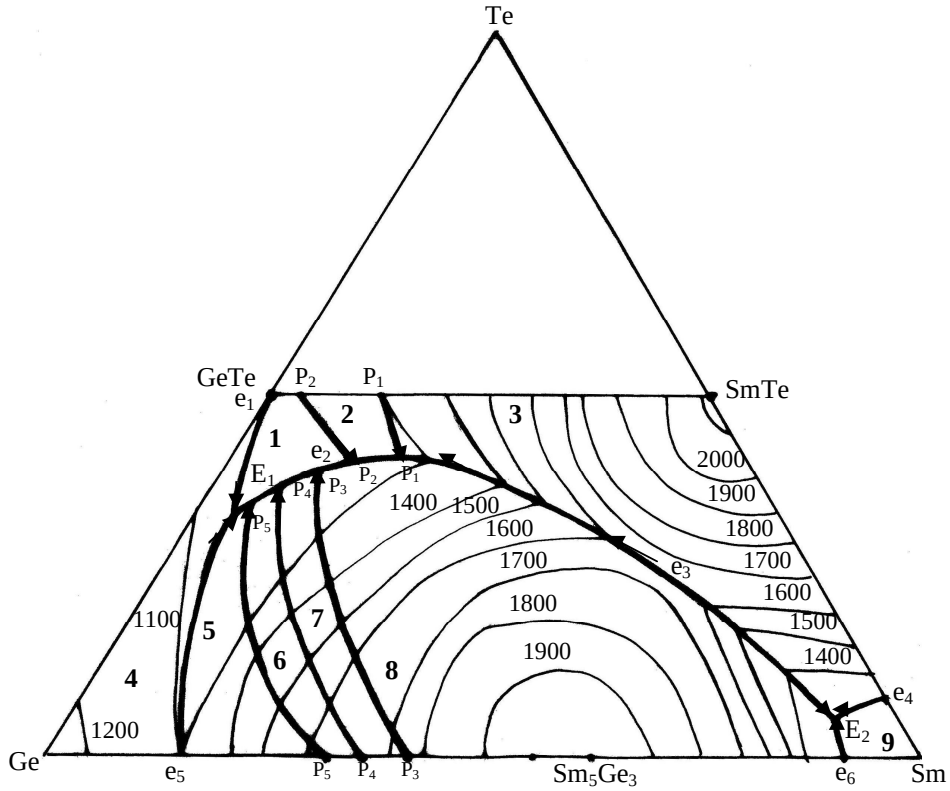

Figure.2. Surface projection of liquidus of triple system Ge-Sm-Te. 1-α(GeTe), 2-s_1($Sm_5Ge_2Te_7$), 3-SmTe, 4-Ge, 5-s_2($SmGe_{1.5}$), 7-s_7(Sm_5Ge_4), 8-Sm_5Ge_3, 9-Sm.

Table 1. Non-variant triple points in system Ge-Sm-Te

Indications of points	Reactions	Temperature, K
E_1	L€ Ge+α(GeTe)+$SmGe_{1.5}$	800
E_2	L€ Sm+γ(SmTe)+β(Sm_5Ge_3)	1120
P_1	L+γ(SmTe)€ $Sm_5Ge_2Te_7$+β(Sm_5Ge_3)	1150
P_2	L+$Sm_5Ge_2Te_7$€ α(GeTe)+β(Sm_5Ge_3)	970
P_3	L+β(Sm_5Ge_3) € Sm_5Ge_4+α(GeTe)	910
P_4	L+Sm_5Ge_4€ SmGe+α(GeTe)	880
P_5	L+SmGe € $SmGe_{1.5}$+α(GeTe)	830

In system there are two points of non-variant equilibrium (E_1, E_2), which are triple eutectic points and five peritectic points.

In Table1 non-variant reactions and temperatures of triple eutectic and peritectic were presented.

For the first time surface projection of liquidus of triple system Ge-Sm-Te was plotted on the grounds of internal sections. Zones of primary crystallization phases, as well as reaction non- and mono variant equilibrium were established.

CONCLUSION

On base of researched internal sections the surface projection of liquidus of triple system Ge-Sm-Te was plotted. The formation of triple incongruent compound $Sm_5Ge_2Te_7$ was established.

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