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Phase Formation in the $Ag_2S–Sb_2S_3–GeS_2$ System

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INTRODUCTION & AIM

The quasi-ternary system $Ag_2S–Sb_2S_3–GeS_2$ is of interest because the ternary compounds Ag_3SbS_3, $AgSbS_2$, Ag_8GeS_6 and Ag_2GeS_3 of the boundary quasi-binary systems $Ag_2S–Sb_2S_3$ and $Ag_2S–GeS_2$ exhibit promising properties that are valuable to semiconductor materials science.

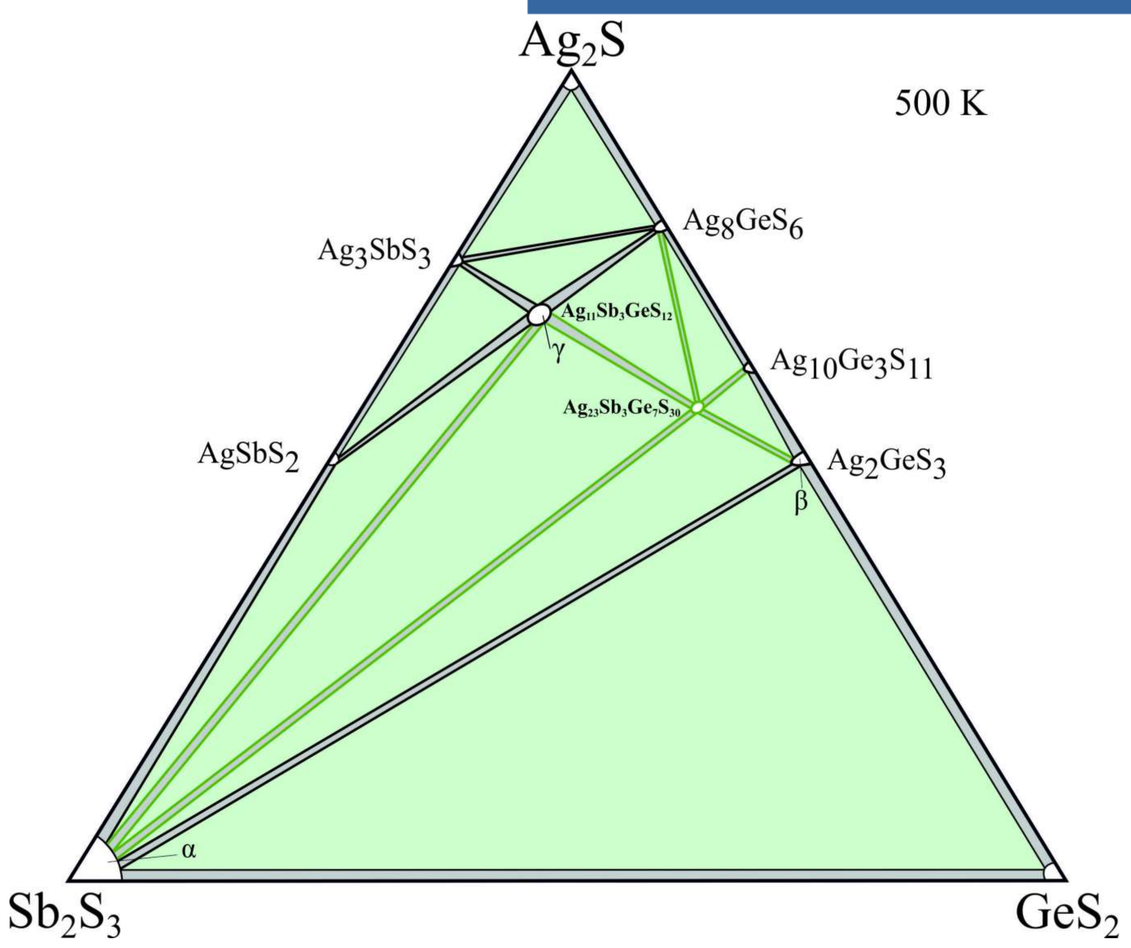
The investigation of phase diagrams helps to optimize the conditions for obtaining new materials to increase their efficiency.

METHOD

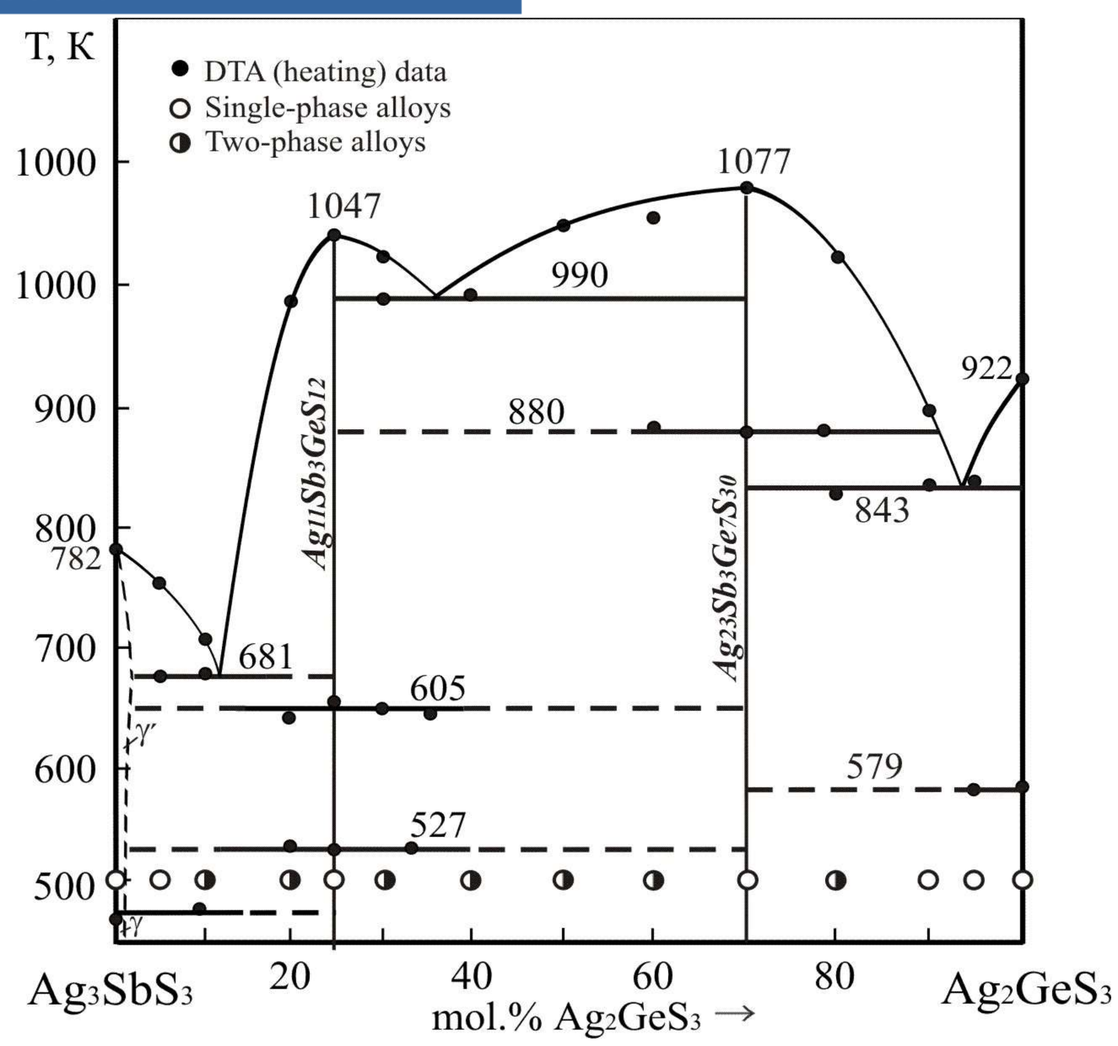
The samples were synthesized from high-purity (> 99.99 wt. %) elements (Ag, Ge, Sb, S) by direct single-temperature method in evacuated quartz ampoules in an MP-60 programmable muffle furnace. The sample mass was 1.5 g. The samples were heated with stops from 670 K every 100 degrees at a rate of 20 K/h. The maximum temperature was 1220 K. After 6 h holding, the temperature was gradually lowered (~10 K/h) to 500 K. The samples were annealed for 500 h, then the alloys were cooled in the furnace off mode.

The interactions in the system were analyzed by powder X-ray diffraction (DRON 4-13 diffractometer, CuKα radiation) and differential thermal analysis (Thermodent-03 furnace, Pt/Pt-Rh thermocouple).

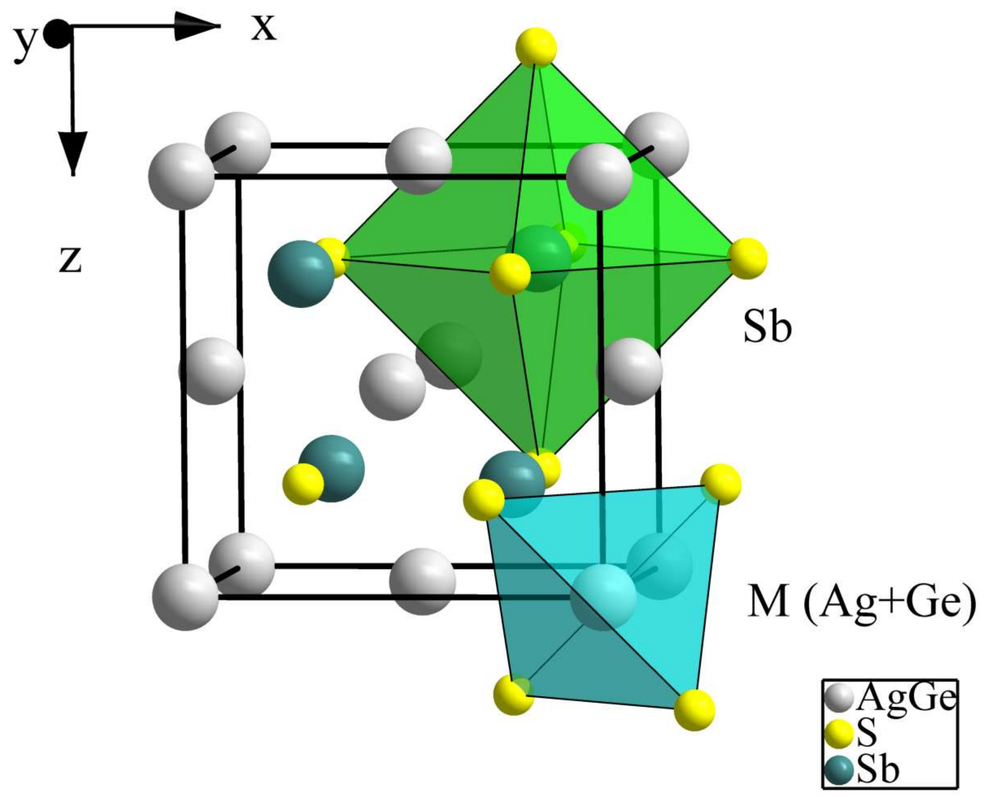
RESULTS & DISCUSSION



Isothermal section of the system at 500 K shows formation of two quaternary compounds, $Ag_{11}Sb_3GeS_{12}$ and $Ag_{23}Sb_3Ge_7S_{30}$.



Vertical section $Ag_3SbS_3–Ag_2GeS_3$. Both quaternary compounds melt congruently. $Ag_{11}Sb_3GeS_{12}$ has two phase transitions, at 527 K and 605 K, while $Ag_{23}Sb_3Ge_7S_{30}$ has one at 880 K.



Unit cell and coordination polyhedra of the statistical mixture M(Ag+Ge) and Sb atoms in the $Ag_{11}Sb_3GeS_{12}$ structure (S.G. *F*-4*3m*).

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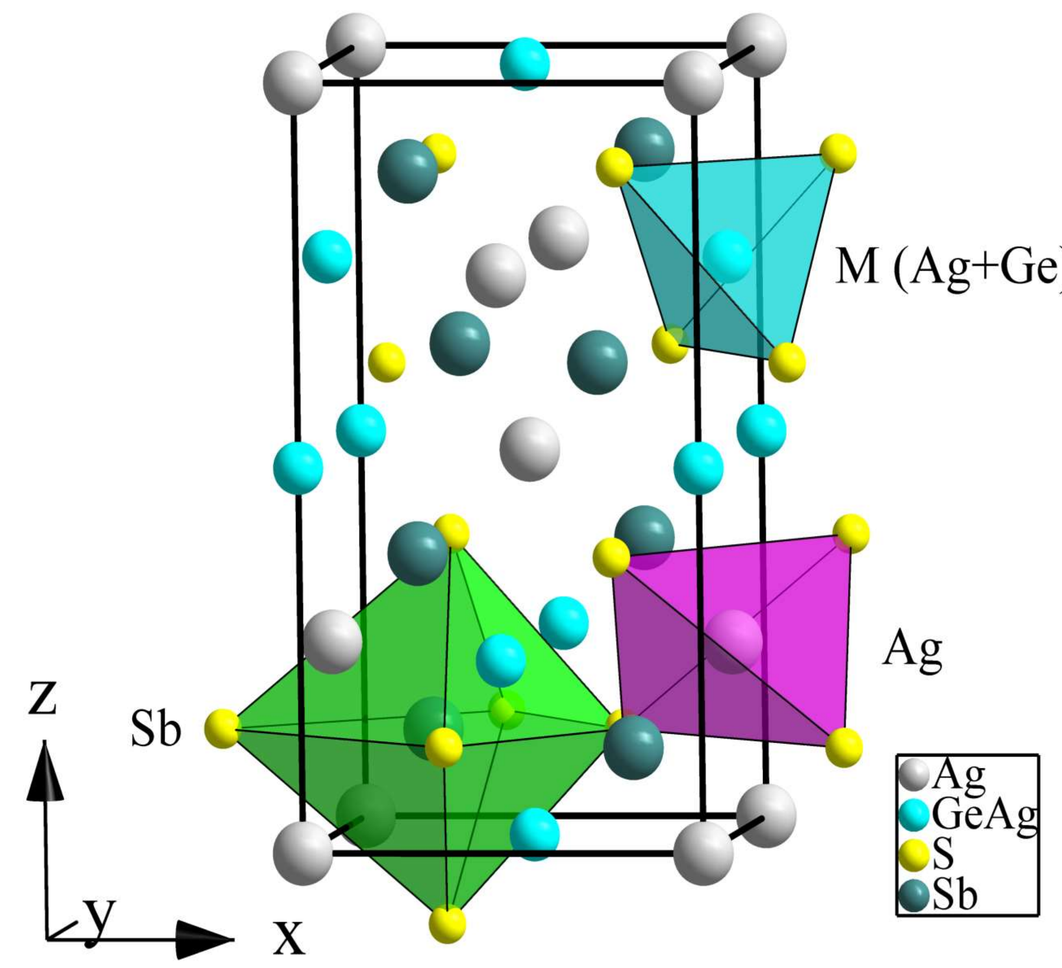
CONCLUSIONS

Two new quaternary compounds, $Ag_{11}Sb_3GeS_{12}$ and $Ag_{23}Sb_3Ge_7S_{30}$, were found. Their thermal behavior with regard to polymorphous transitions was characterized. The crystal structure of each compound was determined.



Unit cell and coordination polyhedra of Ag atoms, statistical mixture M(Ag+Ge) and Sb atoms in the $Ag_{23}Sb_3Ge_7S_{30}$ structure (S.G. *I*-4*2d*).

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