THERMODYNAMIC STUDY OF LAYERED MANGANESE-BISMUTH AND GERMANIUM-ANTIMONY TELLURIDES

Orujlu E.N.[(1)], *Nabiyev E.R.*[(2)], *Bayramova N.A.*[(3)], *Babanly M.B.*[(4)]
[(1)] Azerbaijan State Oil and Industry University
AZ1010, Baku, Azerbaijan, Azadlıq ave., 34
[(2)] Ganja State University
AZ2001, Ganja, Azerbaijan, H. Aliyev ave., 429
[(3)] Institute of Chemistry
AZ1143, Baku, Azerbaijan, H. Javid ave., 113
[(4)] Nakhchivan State University
AZ7000, Nakhchivan, Azerbaijan, Istiglal st., 85

Tetradymite-type layered materials have attracted considerable attention because of their unique structural and electronic properties and their potential for thermoelectric applications, phase-change functionality, and topological insulator behavior. Among these materials, the A-B^V-Te systems (A = Mn, Ge, Sn, Pb; B^V = Sb, Bi) are of particular interest because they include a wide range of compounds with layered crystal structures and diverse functional properties A characteristic feature of these compounds is their layered crystal structure with covalently bonded sheets separated by weak van der Waals gaps. Understanding their thermodynamic behavior is therefore essential for clarifying phase stability, guiding controlled synthesis, and supporting the design of materials for advanced electronic and energy applications.

In the present work, the thermodynamic properties of manganese-bismuth tellurides and germanium-antimony tellurides were investigated by electromotive force measurements under standard conditions. The solid-phase equilibria in the MnTe-Bi_2Te_3-Te and GeTe-Sb_2Te_3-Te systems were studied to identify the relevant heterogeneous regions and to select suitable electrode compositions for reliable electrochemical measurements. It was found that all telluride phases in these systems are connected by tie-lines with MnTe in the manganese-containing system and with elemental tellurium in the germanium-containing system. Based on these results, concentration cells of the type (-) MnTe (GeTe) (solid) | glycerol-KCl | alloys (solid) (+) were assembled. EMF measurements were performed in the temperature range 300-450 K and exhibited linear temperature dependences. Assuming a linear relationship between EMF and temperature, the experimental data were analyzed using the least-squares method, and the relative partial molar functions of manganese or germanium in the alloys were subsequently determined. Taking into account the stability of the coexisting phase compositions in the investigated phase regions, the standard integral thermodynamic functions of the ternary compounds were then calculated using the virtual-cell reaction approach. The obtained thermodynamic data satisfy internal consistency criteria and are consistent with the established phase relations, confirming their compatibility with the Mn-Bi-Te and Ge-Sb-Te phase diagrams.