LONG-TERM RELAXATION PROCESSES IN Ga-REM MELTS

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Gallium-based alloys are attracting researchers' attention in recent years and are considered as promising liquid metal coolants and materials in micro- and nanoelectronics. At the same time, data on their physical properties remain limited, which restricts their broader application. Moreover, such systems have been shown to exhibit long-term changes in their properties at high temperatures [1]. In this work, the physical properties (density and viscosity) of gallium melts containing rare-earth metals (REMs) were investigated, and their behaviour during long-term isothermal exposure at high temperatures was studied.

Binary Ga-REM alloys (REM: Nd, Sm, Gd, Tb, Ho) with the second component present at up to 5 at. % were obtained in a resistance furnace at 1400 K under a protective helium atmosphere. Density of the alloys was measured using the gamma-absorption method on an automated setup, kinematic viscosity was investigated using the damped torsional vibrations method (Shvidkovskiy method). Experiments were carried out under protective helium atmosphere.

It has been established that Ga-REM melts are characterized by long-term relaxation processes, which leads to a discrepancy between density and viscosity values obtained during heating and subsequent cooling. It has been shown that melts above the liquidus temperature are heterogeneous systems, containing two-scale inhomogeneities associated with the first intermetallic compounds of gallium with rare earth metals. The transition of melts to the equilibrium state (relaxation processes) takes tens of minutes and is associated with the dissolution of two-scale inhomogeneities. Relaxation processes can generally be described by a decay equation, which demonstrates the universal mechanism of inhomogeneity dissolution in such melts.

Results obtained in this study can be used to optimise the processes of preparing Ga-REM alloys for practical applications and may provide a basis for further research on the melts of these systems.

1. Rusanova A.I., Son L.D., Rusanov B.A., Beltyukov A.L. Long-term non-monotonic relaxation processes in Al- and Ga-based binary alloys with gadolinium and terbium at high temperatures // Journal of Molecular Liquids. 2026. V. 442. 129116. https://doi.org/10.1016/j.molliq.2025.129116

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