SPECTRAL AND TEMPERATURE DEPENDENCE OF ABSORPTION COEFFICIENT OF MOLTEN ALUMINUM OXIDE

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A critical compilation and analysis of all the available experimental data and approximation formulas for the wavelength and temperature dependences of the absorption coefficient of molten aluminum oxide in semi-transparent spectral range from 0.3 to 8 micrometers and temperature region from melting to 3000 K are presented. The main factors and the influence of physicochemical processes on the value of the absorption coefficient are considered.

It is shown that the available data can be divided into two groups, according to the level of absorption. The first group includes the results of the research of optical properties of solid propellant combustion products, and the second group – the results of the research of single crystal melts and some other high-purity molten aluminum oxides. Discrepancies in the results of different authors in each of these groups are quite big. The explanation lies in the influence of initial material or external conditions, or experimental errors.

On the base of realized analysis, it is shown that the common feature of change of the absorption coefficient with temperature and wavelength in molten alumina tends rather to a semiconductor than to a dielectric. High absorption on Urbach tail, as temperature increases, takes place not only in visible, but also in short infrared region. High multiphonon absorption takes place at wavelength longer than 4.0 micrometers. Between these two regions, absorption is due to free carriers, which are formed by presence of contaminations, impurities, and defects in the local order of atom arrangement.

The abrupt increase of the absorption coefficient of aluminum oxide takes place at melting. The level of this increase is about two orders of magnitude. The results of comprehensive experimental investigations of this effect are presented. Analysis of the most novel investigations of atomic structure of molten alumina shows that molten alumina has gamma-phase-like atom coordination with many defects. This can be the reason of higher value of the absorption coefficient of the melt in comparison with the single crystal. However, the kinetics of restructuring of the alumina has not been investigated to date.