LEAD-BISMUTH SILICATE LOW-TEMPERATURE SEALING GLASS FOR OPTOELECTRONIC PACKAGING

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Optoelectronic devices, critical in telecommunications, computing, and consumer electronics, demand robust packaging solutions to protect and maintain functionality over their operational life. Traditional sealing materials often require high processing temperatures, which can damage sensitive components. Thus, there is a pressing need for low-temperature sealing glasses that can provide robust protection without compromising the integrity of the optoelectronic devices. Lead-bismuth silicate glass emerges as a superior alternative, offering a blend of low processing temperatures and excellent physical and chemical properties.

Using a standard melt-quenching technique, we synthesized glasses with varying compositions. Extensive analysis, including XRD, SEM, FTIR, DTA, and dilatometry, provided insights into their structure, thermal behavior, and crystallization tendencies [1].

The glasses displayed amorphous structures, with thermal analysis indicating improved stability and reduced crystallization risk with increased silicon dioxide content. The maximum glass stability value was found as 166 °C for $70PbO{\cdot}10Bi_2O_3{\cdot}20SiO_2$ glass. Structural analysis highlighted the presence of key building units, influencing the glass's thermal and mechanical properties. Dilatometric measurements showed a wide range of thermal expansion (CTE) values, from 6.8 to 11.1 ppm/°C, and low glass transition temperature (T_g) values (335–475 °C) and dilatometric softening temperature (T_d) values (355–505 °C). The increase in SiO_2 content resulted in lower CTE values and higher T_g and T_d values, attributed to the replacement of weaker Pb–O (101 kJ/mol) and Bi–O (102 kJ/mol) bonds with stronger Si–O (443 kJ/mol) bonds, and the creation of Si–O–Pb bonds.

The findings underscore the potential of lead-bismuth silicate glasses in developing high-performance, low-temperature sealing materials, offering tailored thermal expansion coefficients, low glass transition temperatures, and improved thermal stability, which are crucial for the reliability and longevity of optoelectronic devices.

References

1. Hordieiev Y.S., Zaichuk A.V. Structure, thermal and crystallization behavior of lead-bismuth silicate glasses. Results in Materials. 2023. Vol. 19. Art. No. 100442.