

Laser Heated Gradient NMR Studies of Ceramic Liquids

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DMR01-16361

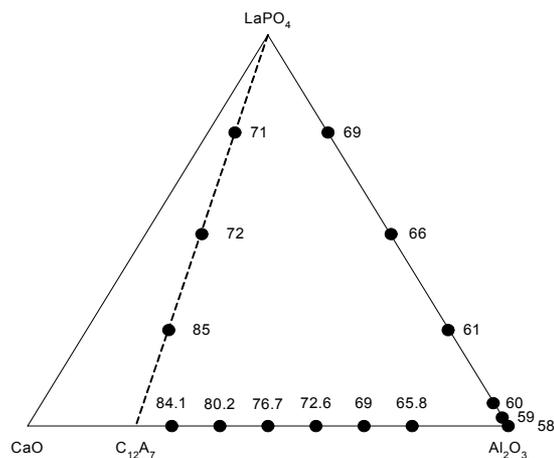
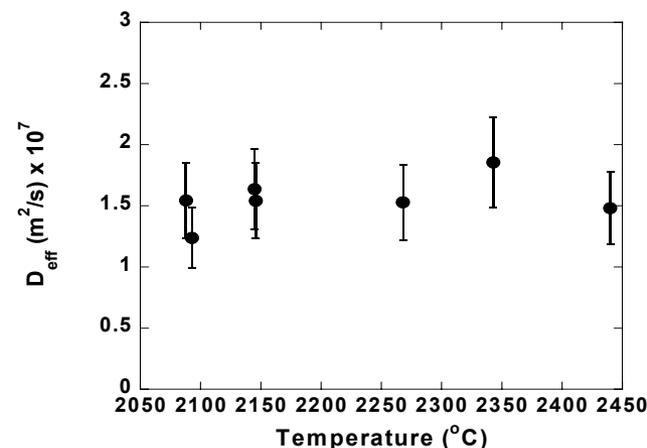


Diagram showing degree of tetrahedral bonding, indicated numerically by the Al NMR chemical shift, in multicomponent ceramic melts containing alumina, La-monazite (LaPO₄) and CaO (high Al shift value → 4-fold Al coordination).

Interpretation: coordination of Al³⁺ in La-rich phases is not 100% 4-fold, i.e. Al-O bonding not the strongest possible. Monazite is used in ceramic matrix composites as an interphase material, and does not mix atomically with Al₂O₃.

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During Al chemical shift determinations in multicomponent ceramic liquid systems, we found that quenching samples high in monazite yielded the little-studied double phosphate LaCa₃(PO₄)₃. This ceramic eutectic of LaPO₄ and Ca₃(PO₄)₃ melts at 1890 Celsius, and is atomically dissolved in melts with La-monazite fractions < 50%.



Total Al diffusivity D_{total} measured (for the first time) by NMR, in Ar gas-levitated molten alumina samples, vs. temperature. D 's very high values (~ 200 times > water

at 25 °C) and lack of T-dependence indicate that the diffusive motions measured arise mainly from bulk sample motions - rotation and/or random convection currents.

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Education

Graduate student Susan Boucher plans to complete her M.S. degree in Chemistry under the direction of Prof. Wolf, by December 2003. She has developed methods for production of diverse multicomponent ceramic samples, many containing alumina and monazite, over the past year. Undergraduates who have worked with Ms. Boucher include Susan Weinstein (Chemistry and Biochemistry) and Laura Sparks (Physics and Astronomy).

Experiments and probes continue to be developed in the NMR laboratory, by former Master's student J. Piwowarczyk.

Outreach

A talk was given in a Physics and Astronomy series of seminars on research activities available to graduate students in the department. Strong interest was generated by the discussion of the ultra high-temperature NMR project