

# THERMAL AND DIELECTRIC PROPERTIES OF BOROSILICATE GLASSES – EFFECT OF B<sub>2</sub>O<sub>3</sub>/SiO<sub>2</sub> RATIO

A.A.S.LOPES<sup>1</sup>; R.C.C.MONTEIRO<sup>1</sup>; C.J.DIAS<sup>1</sup>; L.F.R.DAVIM<sup>2</sup>; E.J.R.DAVIM<sup>2</sup> and M.H.V.FERNANDES<sup>2</sup>

<sup>1</sup>Departamento de Ciência de Materiais, CENIMAT/I3N, Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, 2829-516 Caparica

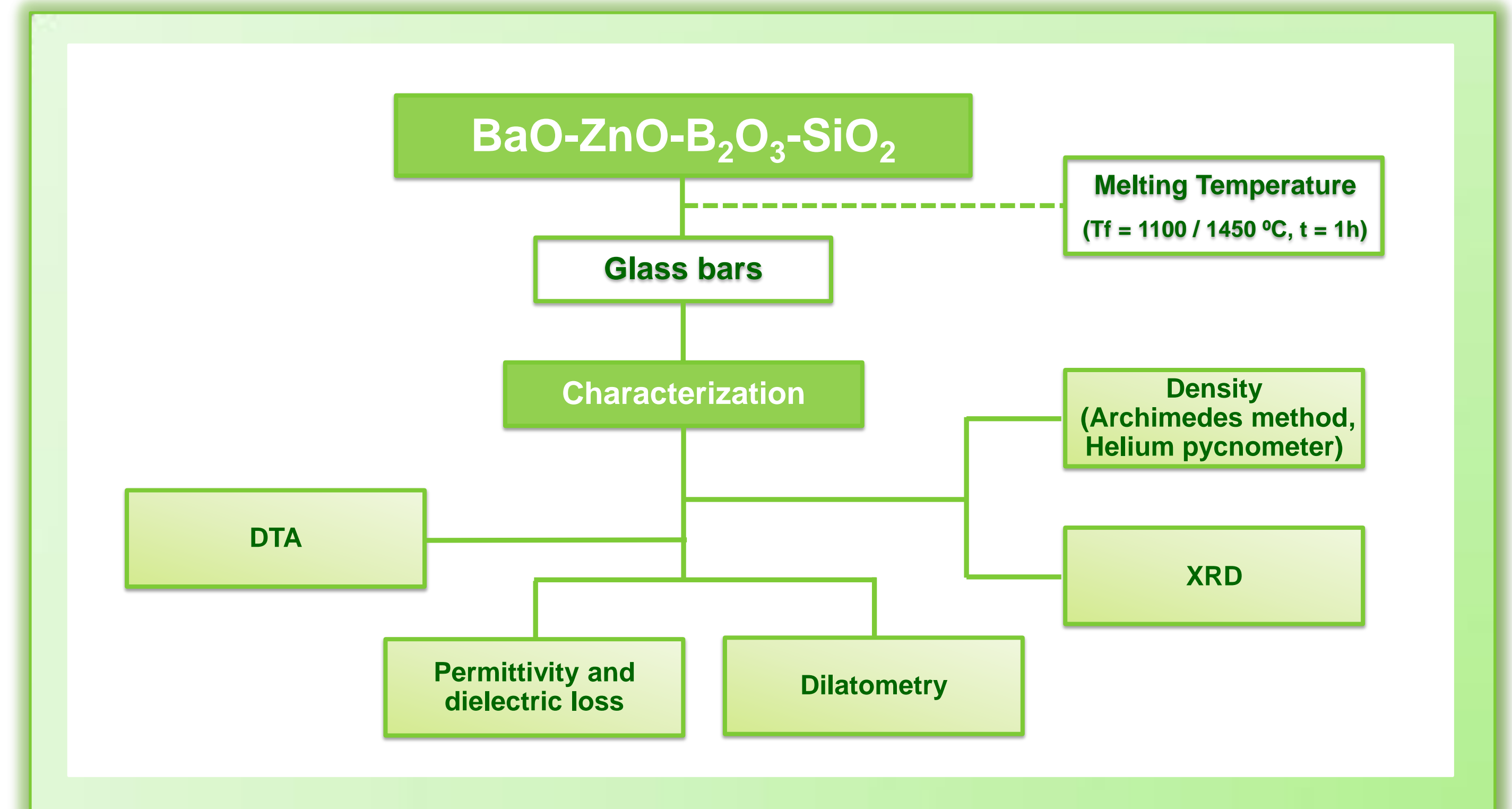
<sup>2</sup>Departamento de Engenharia de Materias e Cerâmica & CICECO, Universidade de Aveiro, 3810-193 Aveiro

## INTRODUCTION

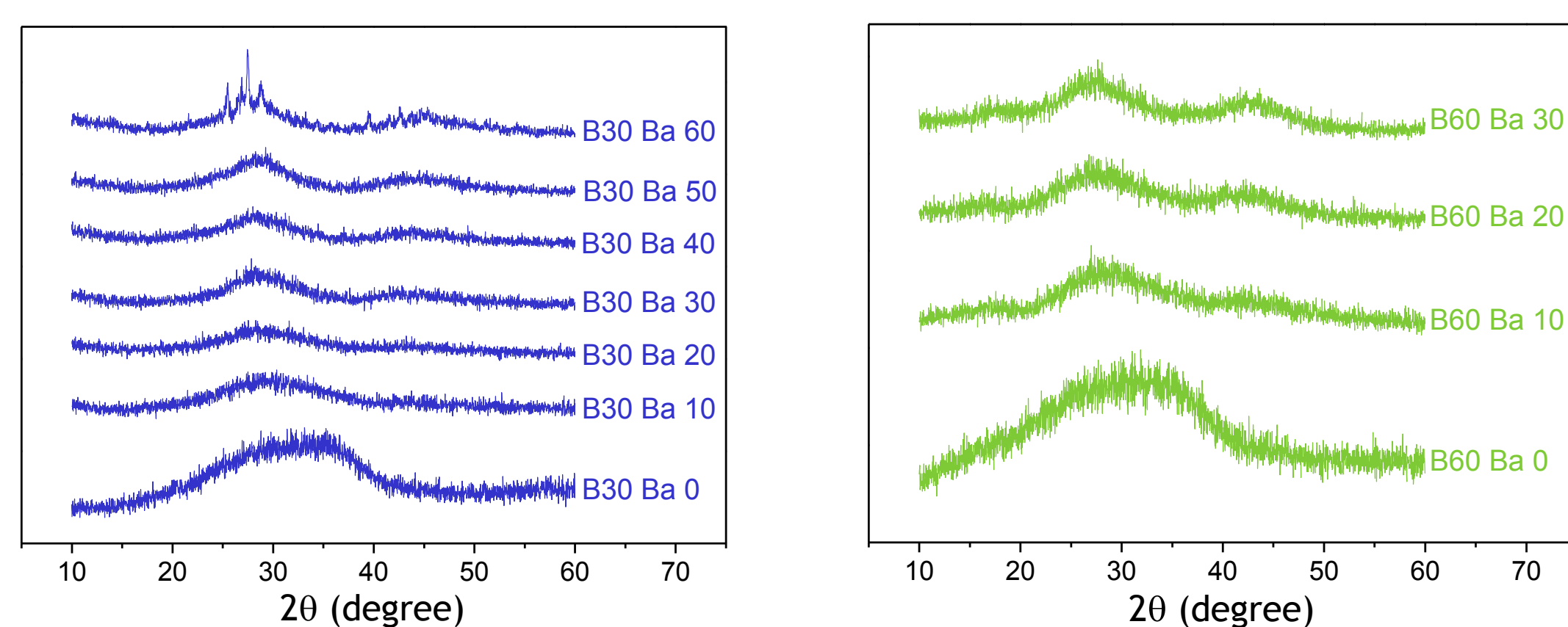
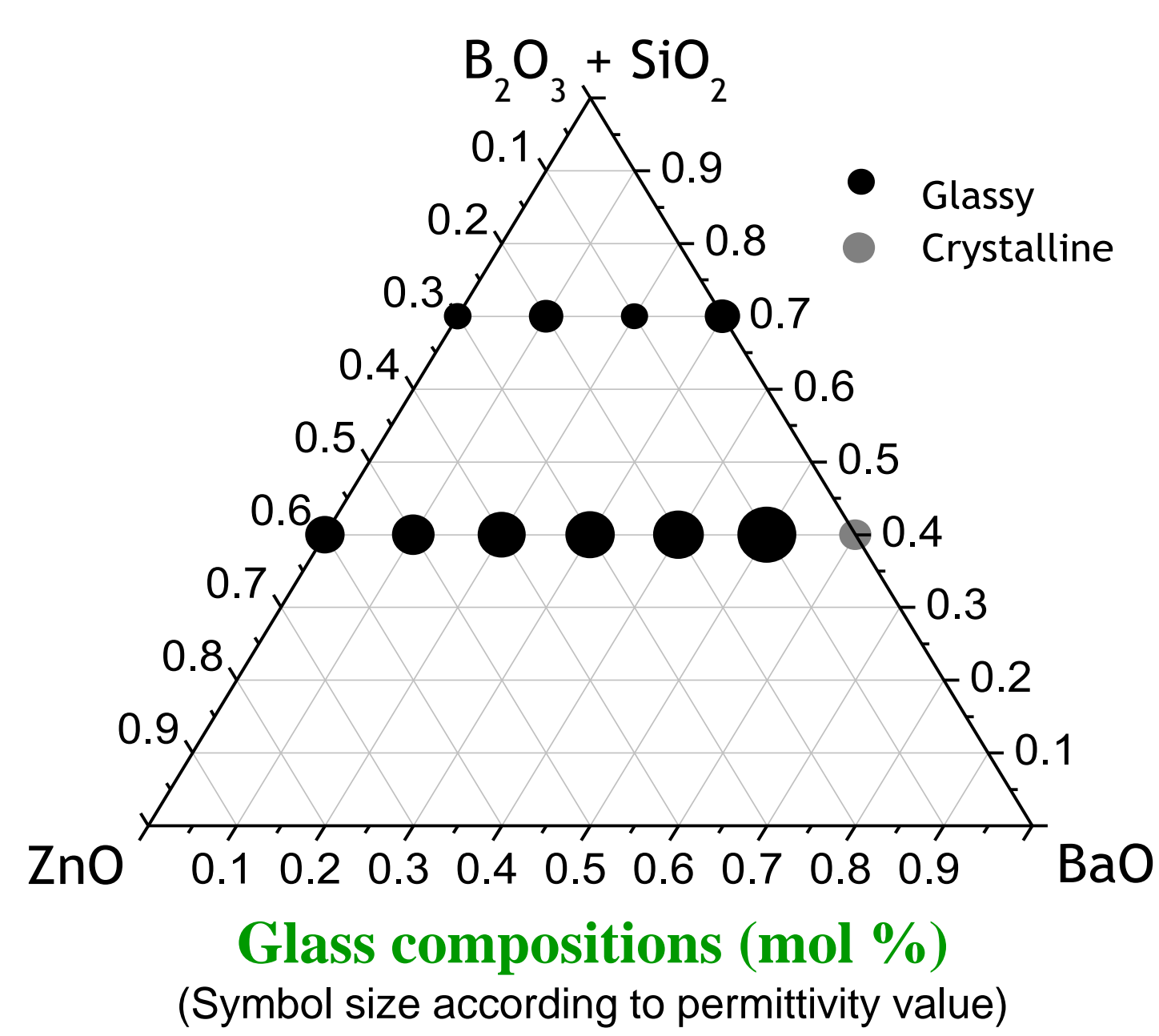
Borosilicate glasses, due to their low softening temperature, low thermal expansion and low dielectric constant, have been considered promising materials for different electronic industrial applications. These materials contain usually PbO, a glass network modifier with adverse health and environmental effects during processing, forcing the search for safer alternatives. Recently, BaO and ZnO have been used as potential candidates that can replace PbO.

Two series of glasses based on BaO-ZnO-B<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub> system were developed, where the amount of SiO<sub>2</sub> was fixed at 10 mol%, the amount of B<sub>2</sub>O<sub>3</sub> was 30 or 60 mol% (B30 or B60), and the network modifier ZnO was gradually substituted by BaO. Bulk transparent glasses were obtained by the conventional melting route, casting and annealing steps. The goal of this study is to evaluate the effect of compositional changes on the thermal and dielectric properties.

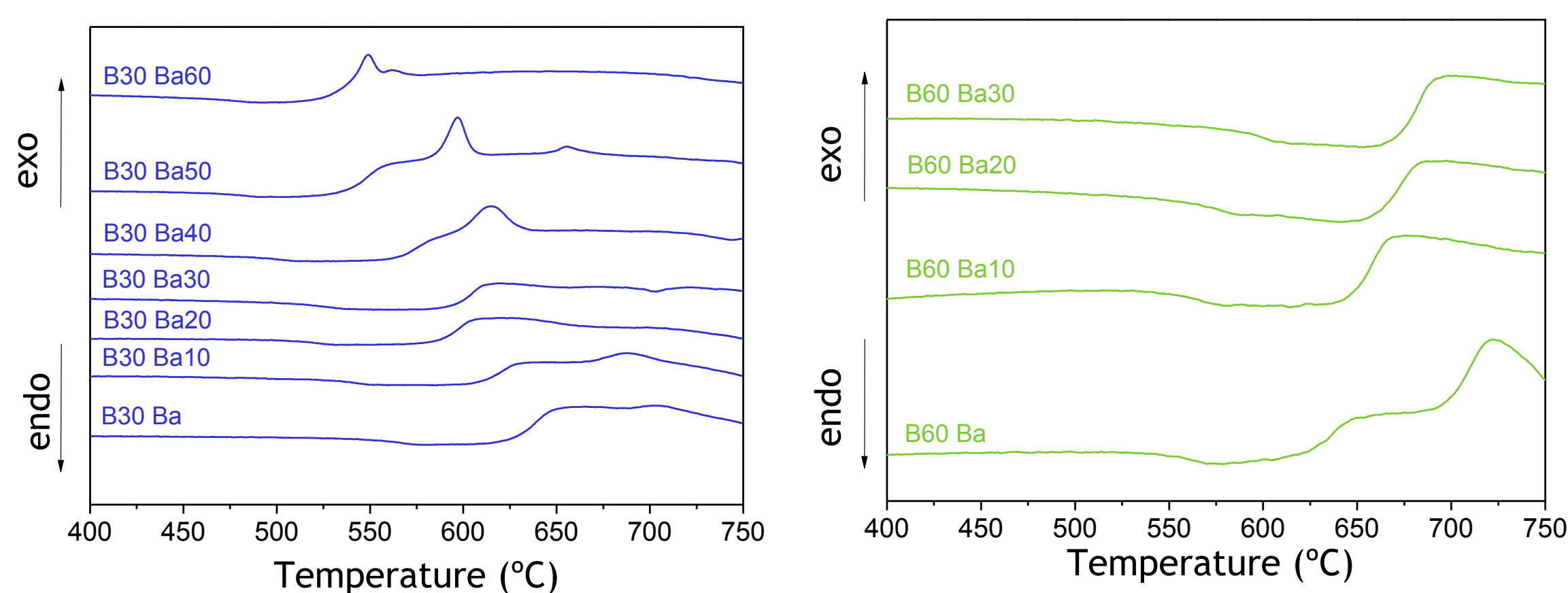
## EXPERIMENTAL



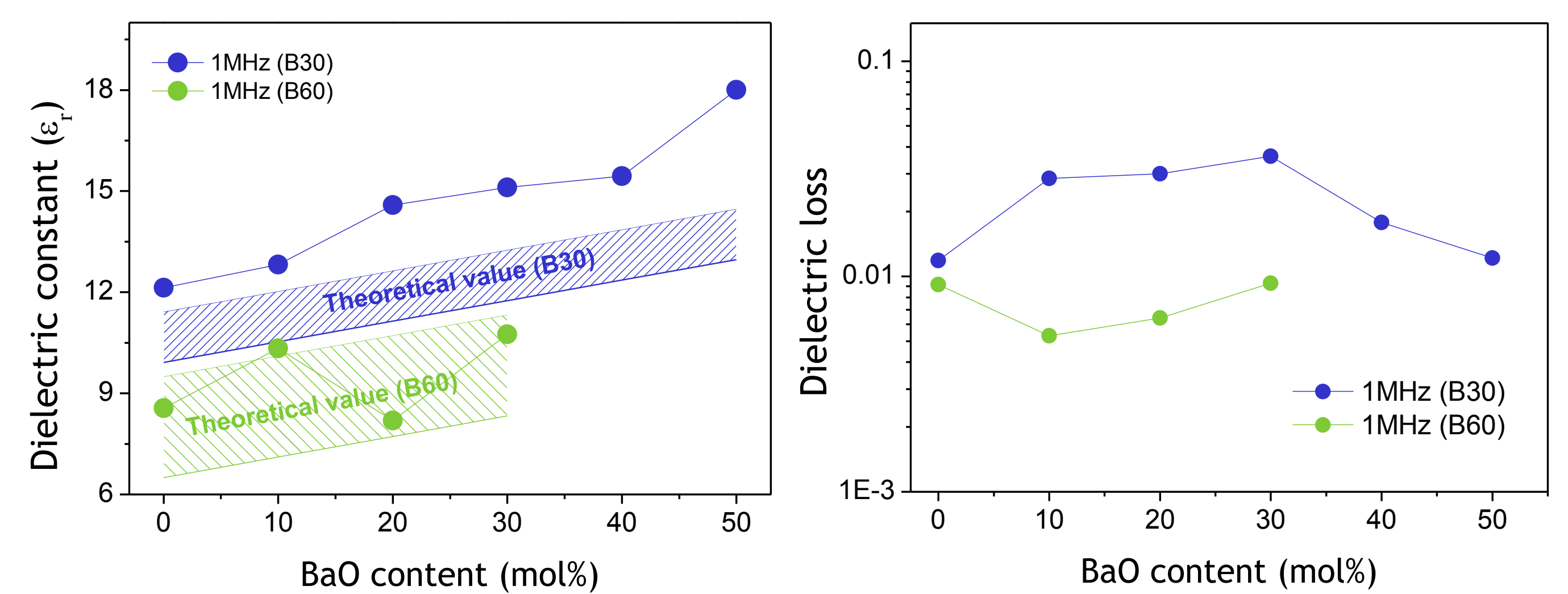
## RESULTS



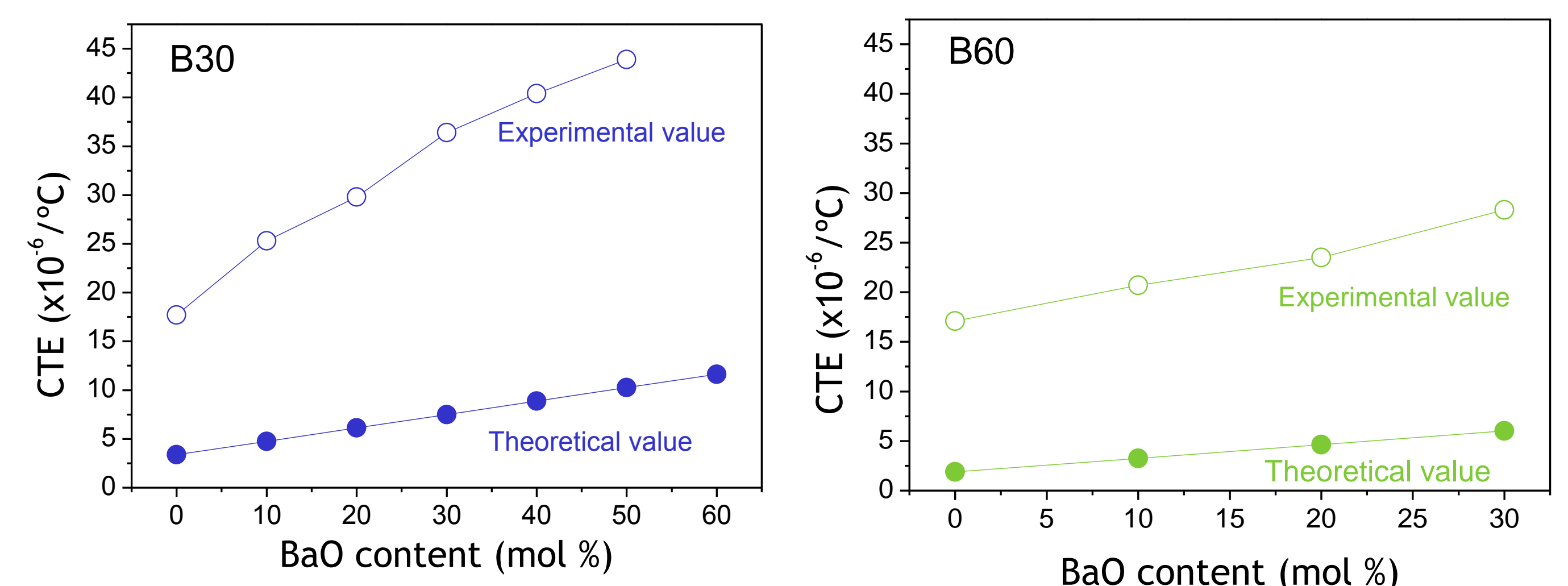
XRD patterns for the 2 series of glasses



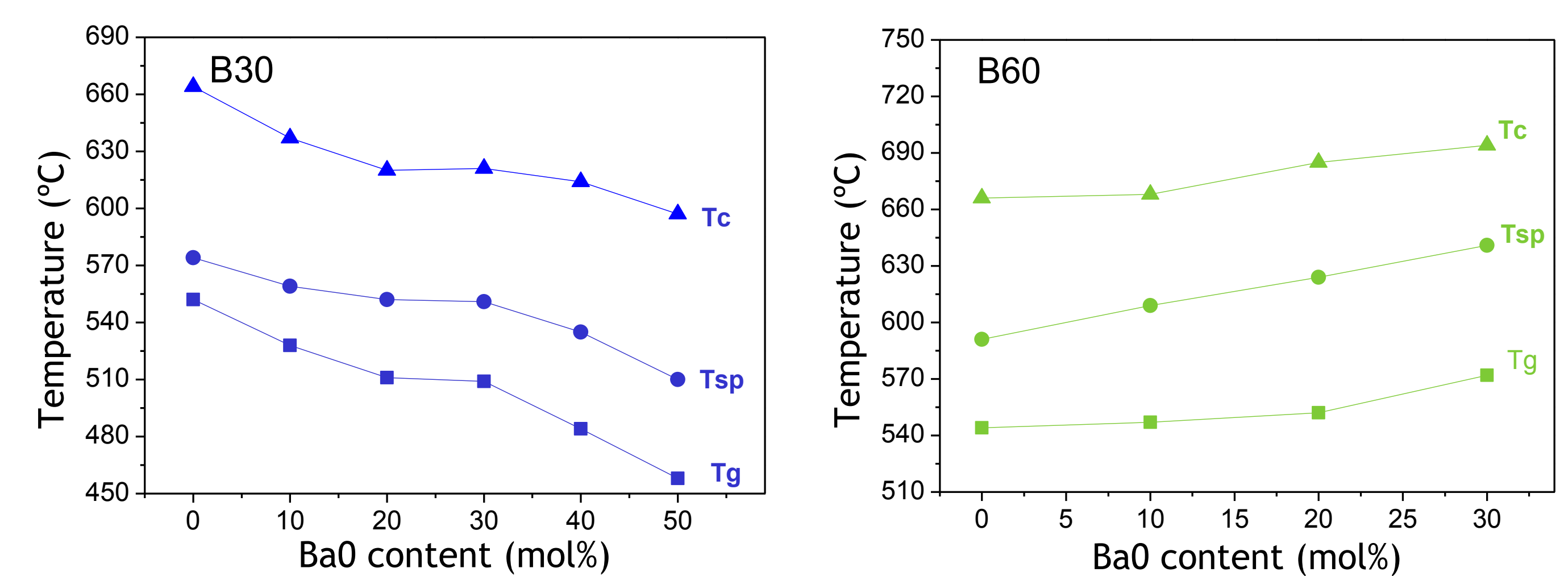
DTA curves for the 2 series of glasses



Dielectric constant and dielectric loss as a function of BaO content



Coefficient of thermal expansion (CTE) of each specimen as a function of BaO content



Change of glass transition temperature (Tg), softening temperature (Tsp) and crystallization temperature (Tc) with BaO content for the 2 series of glasses

## CONCLUSIONS

- For a fixed BaO content, the glass transition, softening and glass crystallization temperatures increase with the B<sub>2</sub>O<sub>3</sub>/SiO<sub>2</sub> ratio.
- Increasing the BaO content in series B30 decreases the glass transition, softening and glass crystallization temperatures, whereas the opposite effect is observed in B60 series. The non-linear behaviour of the glass characteristic temperatures between the two glass series is interpreted in terms of boron anomaly phenomenon, i.e. BO<sub>4</sub> tetrahedra transform into BO<sub>3</sub> groups in B30 and the opposite occurs in B60 series.
- Increasing the BaO content increases the CTE and the dielectric constant whereas increasing B<sub>2</sub>O<sub>3</sub>/SiO<sub>2</sub> ratio decreases both CTE and dielectric constant. These results show that Ba ions have a stronger effect on the glass network disruption and decrease of rigidity compared to Zn ions.