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## A quasielastic and inelastic neutron scattering study of the alkaline and alkaline-earth borohydrides $\text{LiBH}_4$ , $\text{Mg}(\text{BH}_4)_2$ and the mixture $\text{LiBH}_4 + \text{Mg}(\text{BH}_4)_2$

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Quasielastic neutron scattering was used to investigate the low energy transfer dynamics of the complex borohydrides  $\text{Mg}(\text{BH}_4)_2$  in the  $\alpha$ - and  $\beta$ -modifications,  $\text{LiBH}_4$  in the low and high temperature crystal structure, and the 1:1 molar mixture of  $\text{LiBH}_4 + \alpha\text{-Mg}(\text{BH}_4)_2$ . All investigated compounds show a rich dynamic behavior below an energy range of  $\Delta E = 10$  meV with the superposition of rotational dynamics of the constituent  $[\text{BH}_4]^-$  anions and low lying lattice modes. For  $\text{Mg}(\text{BH}_4)_2$ , the rotational diffusion of the  $[\text{BH}_4]$  units was found to be much more activated in the metastable  $\beta$ -polymorph compared to the  $\alpha$ -phase, and the low lying lattice modes are even softer in the former crystal structure. In  $\text{Mg}(\text{BH}_4)_2$ , the structural phase transition is mainly governed by the lattice dynamics, while alkaline  $\text{LiBH}_4$  exhibits a transition of the  $[\text{BH}_4]$  rotations around the phase transition temperature. Ball milled  $\text{LiBH}_4 + \alpha\text{-Mg}(\text{BH}_4)_2$  remains a physical mixture of the parent compounds and each component retains its characteristic dynamic signature up to the melting temperature.

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