Utrecht University

Debye Institute for Nanomaterials Science

MCC Materials Chemistry and Catalysis

Interface effects in solid-state electrolytes for lithium-ion batteries

Jonas D. Hehn, Petra E. de Jongh and Peter Ngene
Materials Chemistry and Catalysis, Debye Institute of Nanomaterials, Utrecht University, The Netherlands
E-mail: j.d.hehn@uu.nl

Introduction

The effects of interfacial reactions on the electrochemical properties of nanocomposite and hybrid solid electrolytes for batteries is investigated with the goal to develop a detailed understanding of the nature of the interface interactions. Emphasis is placed on the ionic conductivity and structural properties of the interface layers. Lithium complex metal hydrides, such as $Li_2B_{12}H_{12}$, are used in combination with polymers and inorganic fillers to synthesize polymer-based hybrid solid electrolytes. The fundamental knowledge is crucial for the development of new electrolytes with tailor-made properties for applications in all-solid-state Li-ion batteries.

Nanostructuring:
reducing the grain size by ball milling

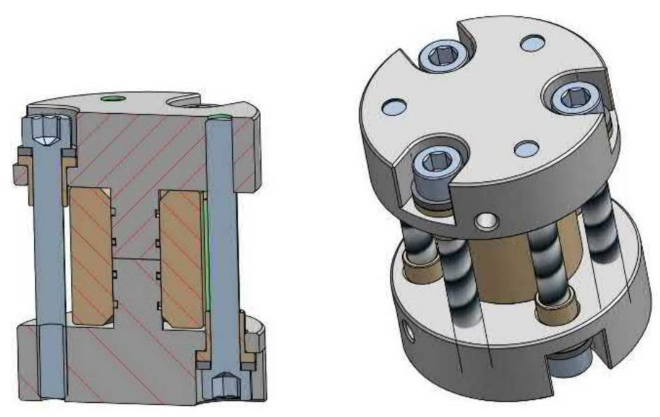
Interface engineering:
intimacy contact with oxides
$Li_2B_{12}H_{12}$ + γ-Al_2O_3 or SiO_2

Ionic substitution:
partial replacement of the anion
$Li_2B_{12}H_{12}$ + $LiCB_{11}H_{12}$

$Li_2B_{12}H_{12}$ + oxide → (dry mix, ball milling)

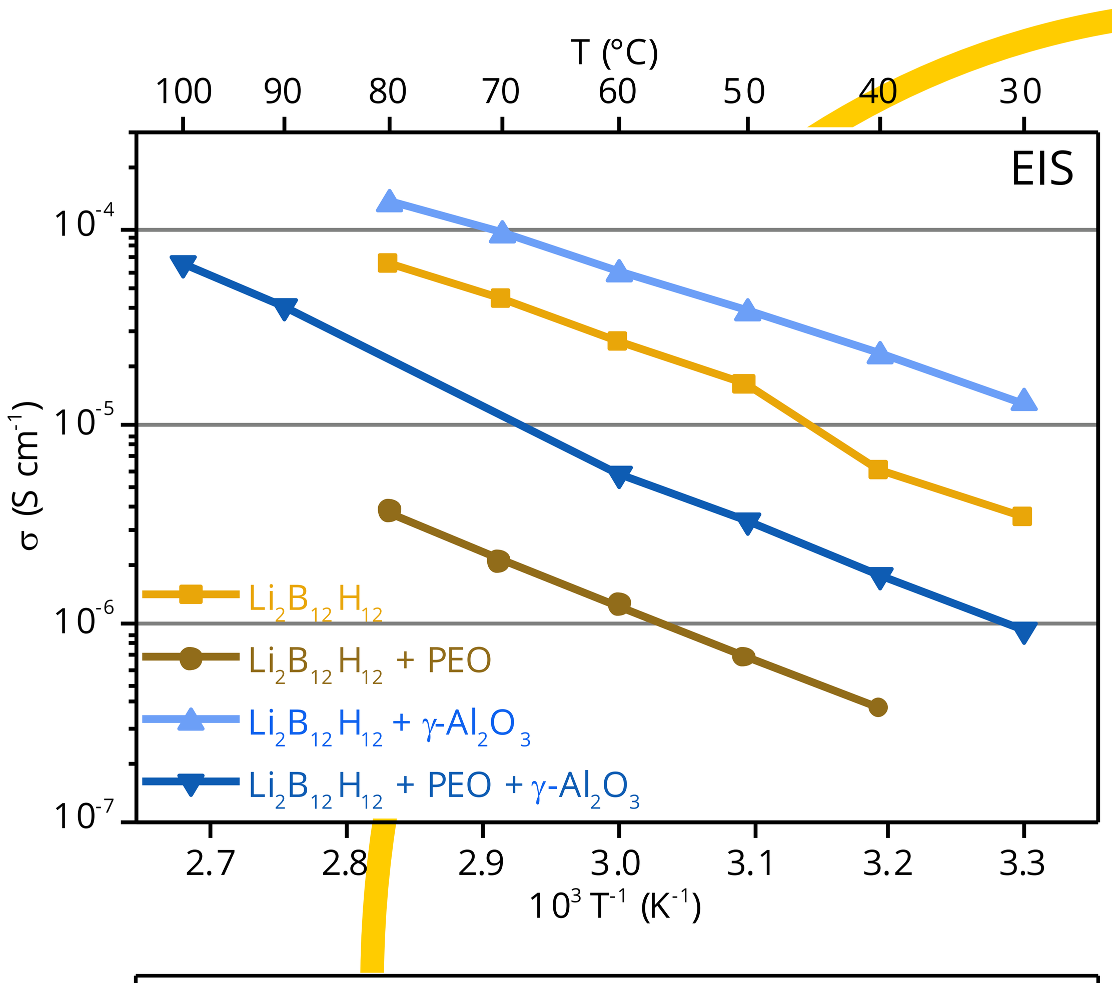
$Li_2B_{12}H_{12}$ + oxide → (+ polymer, ball milling)

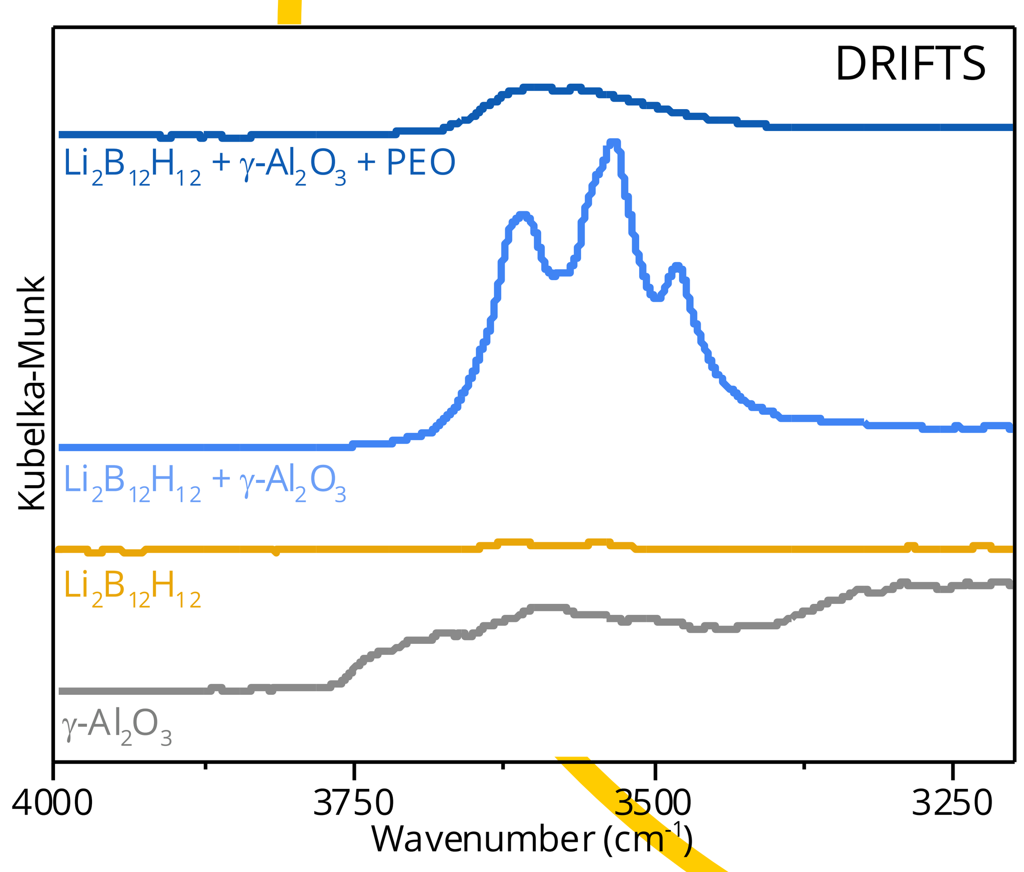
$Li_2B_{12}H_{12}$ + oxide + polymer → (pelletize)



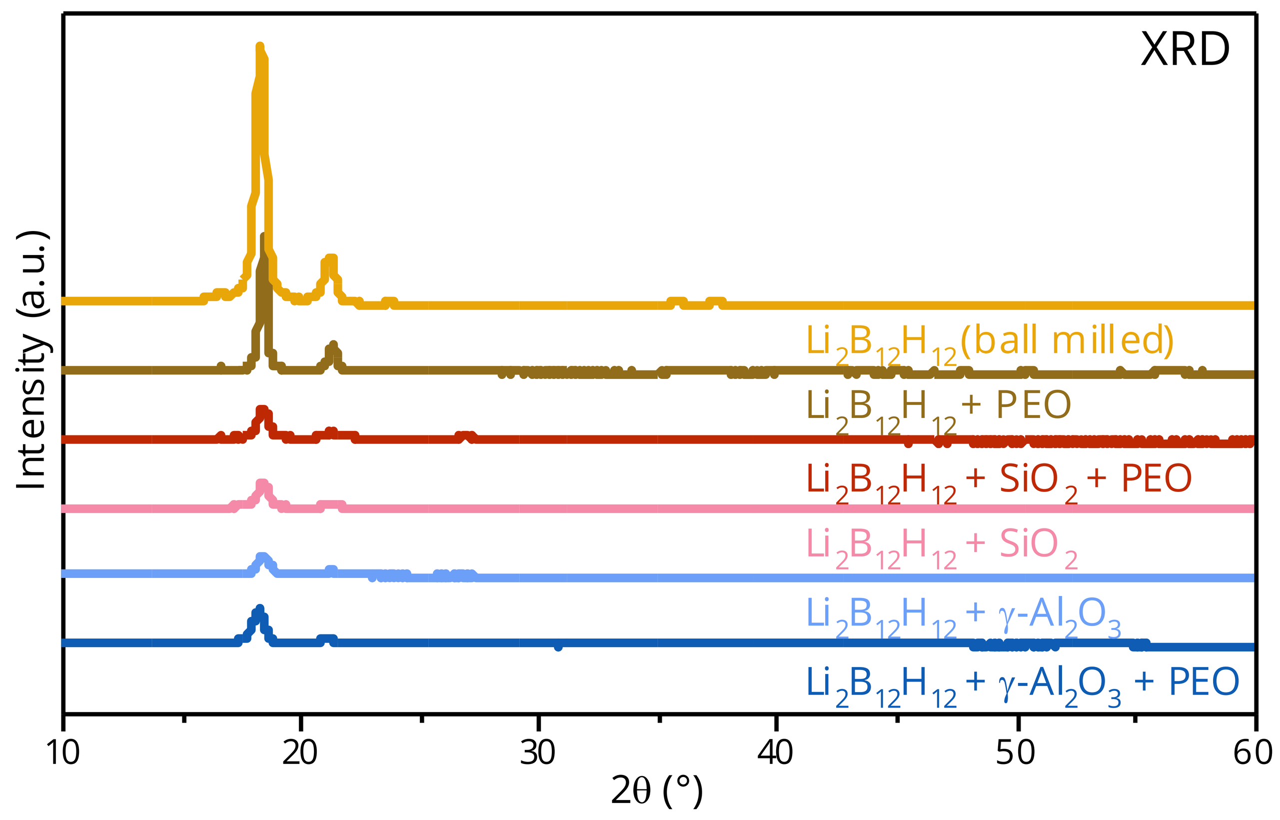
electrochemical test cell

$Li_2B_{12}H_{12}$ + γ-Al_2O_3 electrolytes

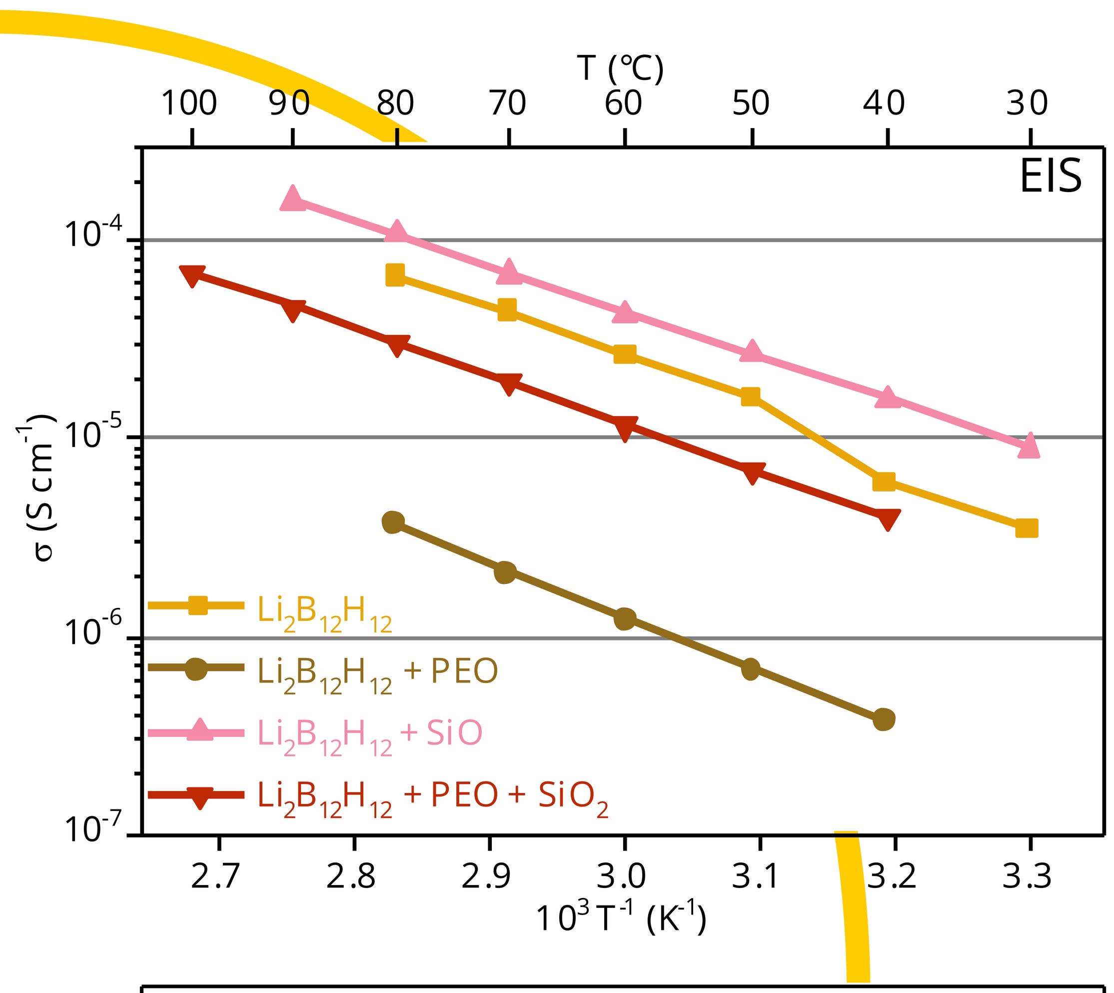


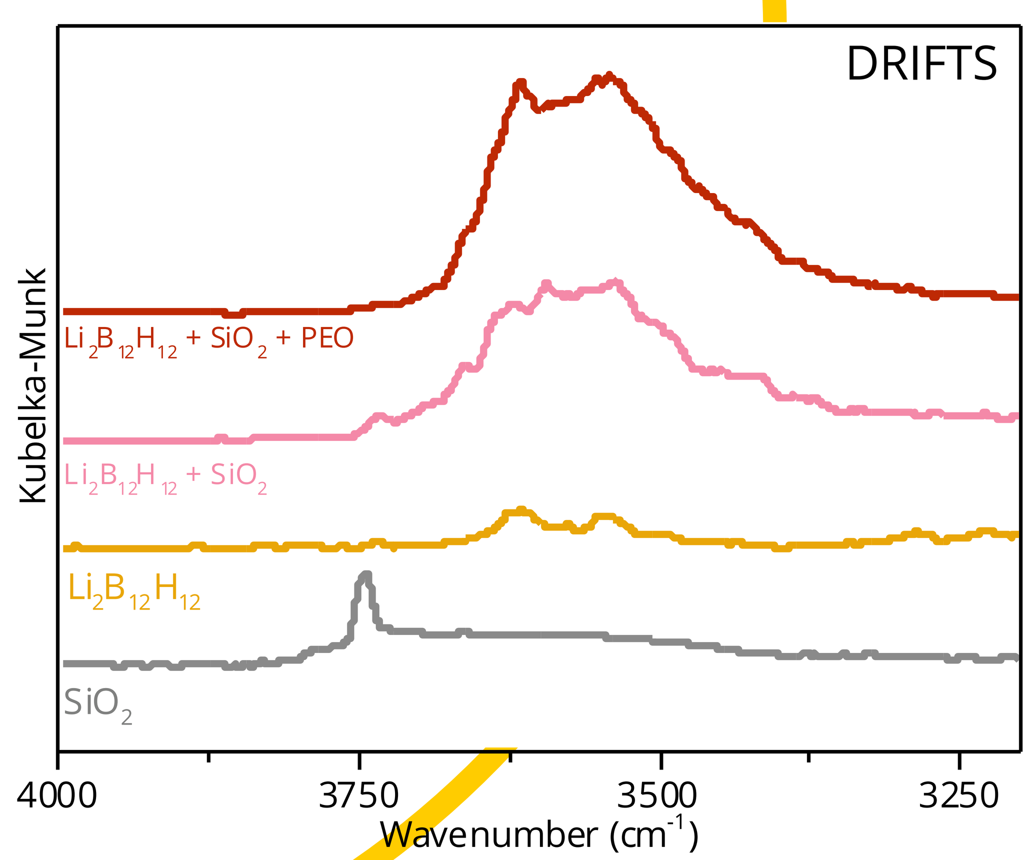


	PEO wt%	oxide v/v%	oxide wt%	BET oxide
SiO_2	0 %	25 %	38 %	271 m²/g
PEO + SiO_2	10 %	21 %	35 %	-
γ-Al_2O_3	0 %	25 %	53 %	184 m²/g
PEO + γ-Al_2O_3	10 %	21 %	48 %	-



$Li_2B_{12}H_{12}$ + SiO_2 electrolytes





CONCLUSIONS

- nanoconfinement with oxide materials leads to enhanced Li-ion mobility
- scaffold surface groups interact with $Li_2B_{12}H_{12}$
- nanostructured samples exhibit reduced crystallinity
- higher conductivity measured without polymer

BatteryNL
DUTCH BATTERY MATERIALS

Acknowledgements
This project has received funding from the Dutch Research Agenda - Research along Routes by Consortia 2020-21 (NWA-ORC), project no. 1389.20.089 of the Dutch Research Council (NWO). The authors would like to thank H.P. Rodenburg, K. S. Kotalgi and R. Dalebout for general and technical assistance.

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