TOWARDS SOLID-STATE MAGNESIUM BATTERIES: TITANIUM DISULPHIDE AS CATHODE MATERIAL USING AN AMINE MAGNESIUM BOROHYDRIDE ELECTROLYTE

Lasse N. Skov*, Jakob B. Grinderslev, Torben R. Jensen

Interdisciplinary Nanoscience Center (iNANO) and Department of Chemistry, University of Aarhus, DK-8000 Aarhus, Denmark

*e-mail: lnskov@inano.au.dk

New battery technologies are explored to accommodate the increasing demand for higher energy density, lower prices and higher safety. Magnesium-based technologies is a promising option, due to a higher abundancy and higher energy density using an Mg-metal anode, as compared to the commercialized Li-ion technology. An existing safety concern with commercial Li-ion batteries is the risk of thermal runaway, which can be minimized by replacing the hazardous organic solvents with a solid-state electrolyte. In both liquids and solids, good and compatible electrolytes have been an issue for magnesium batteries.[1] Recently, a major increase in ionic conductivity was achieved for solid electrolytes, where the addition of a neutral ligand can enhance the conductivity by several orders of magnitude.[2,3] However, a rechargeable solid-state magnesium battery have not yet been reported.

Here we present a solid-state magnesium battery based on amine magnesium borohydride as the solid-state electrolyte and titanium disulphide as the cathode. The intercalation mechanism of Mg^{2+} in titanium disulphide is investigated by synchrotron radiation powder X-ray diffraction revealing four different TiS_2 phases. Furthermore, we investigate the influence of the TiS_2 particle size on the battery performance. The highest specific discharge capacity is achieved at C/50 and T = 60 °C resulting in 172 mAh g^{-1} on the first discharge, which corresponds to x = ~0.36 in Mg_xTiS_2. The performance of the cell chemistry is evaluated by utilizing different cut-off voltages in constant current constant voltages charging, effectively leading to better battery performance.

[1] R. Mohtadi, O. Tutusaus, T. S. Arthur, Z. Zhao-Karger, M. Fichtner, *Joule* **2021**, *5*, 581.

[2] J. B. Grinderslev, M. B. Amdisen, L. N. Skov, K. T. Møller, L. G. Kristensen, M. Polanski, M. Heere, T. R. Jensen, *Journal of Alloys and Compounds* **2021**, 163014.

[3] Y. Yan, J. B. Grinderslev, M. Jørgensen, L. N. Skov, J. Skibsted, T. R. Jensen, *ACS Appl. Energy Mater.* **2020**, *3*, 9264.

Lasse got his bachelor in Nanotechnology from Aalborg University in 2016, and returned to university to take his master's degree at Aarhus University after a year in industry. Lasse wrote his master thesis about fabrication and upscaling of organic pouch cell batteries at the department of engineering, and got his master's degree in 2019.
Currently, Lasse is writing his PhD thesis about solid-state magnesium batteries at the "Nano Energy Materials" group under supervisor Professor Torben René Jensen at the department of Chemistry & iNANO, Aarhus University. Lasse is mainly working with solid-state and post-lithium battery technologies and electrochemical energy conversion.