Supporting Information

Electrochemically Induced Crystallization of Amorphous Materials in Molten MgCl₂: Boron Nitride and Hard Carbon

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**Figure S1:** TEM images of hard carbon prior to electrochemical treatment

**Figure S2:** TEM images of EGC post electrochemical treatment in molten MgCl$_2$
**Figure S3:** SEM images of hard carbons prior to electrochemical treatment

**Figure S4:** SEM images of EGC post electrochemical treatment in MgCl₂
Figure S5: SEM images of amorphous BN prior to electrochemical treatment in MgCl₂.

Figure S6: SEM images of h-BN post electrochemical treatment.

Figure S7: TEM images of amorphous BN prior to electrochemical treatment.
Figure S8: TEM images of h-BN post electrochemical treatment in MgCl₂

Figure S9: Cycling stability and charge-discharge profiles for commercial synthetic graphite.
Figure S10: Cycling stability and charge-discharge profiles for hard carbon.
Figure S11: Comparison of cyclic voltammetry of EGC, synthetic graphite, and hard carbon at a scan rate of 0.1 mV s$^{-1}$ vs. Li/Li$^+$. 

**MgCl$_2$ Dehydration:**

Dehydration of MgCl$_2$, which forms hydrates with up to 12 hydration waters, proceeds with the sequential release of water down to the monohydrate. Upon further heating, the monohydrate hydrolyzes into MgO and HCl[1]. To aid in the dehydration of MgCl$_2$ while preventing hydrolysis, ammonium chloride has been used. When heated in the presence of hydrated MgCl$_2$, ammonium chloride forms a carnallite intermediate that facilitates the release of water[2,3].

$$\text{MgCl}_2 \cdot n\text{H}_2\text{O} + \text{NH}_4\text{Cl} \rightarrow \text{MgCl}_2 + \text{NH}_3(\text{g}) + \text{HCl}(\text{g}) + \text{H}_2\text{O}$$
Commercial anhydrous MgCl$_2$ (Alpha Aesar, 99.9%) was stored in a vacuum oven at 120 °C. 500 g of MgCl$_2$ ·xH$_2$O was weighed and mixed with 250 g of NH$_4$Cl (Alpha Aesar, 99%). The mixture was then added to a 12-inch long quartz crucible with a 3-inch inner diameter. The crucible was placed in a quartz reactor equipped with a sealed, removable 3-port head. The assembled reactor was placed in a Lindberg Blue tube furnace, and the reactor was purged with UHP Ar (Airgas) for 1 hour. UHP Ar was constantly flowing at 0.5 L/min during the heating and cooling. The salt was heated from room temperature to 400 °C at 20 °C/min and held at this temperature for 2 hours. The salt mixture was then heated to 850 °C at 20 C/min for 1 hour to remove excess ammonium chloride and fuse MgCl$_2$. After 1 hour at 850 °C the furnace was turned off and allowed to cool to room temperature. Once cooled, the reactor was kept under UHP Ar and was transferred into a UHP Ar-blanketed glovebox. The fused MgCl$_2$ salt was retrieved and was broken into smaller pieces. The salt was then stored in Mason jars inside the glovebox before being used for the electrochemical experiments.

**Synthesis of BN:**

0.05 mol boric acid and 1.2 mol urea were dissolved in deionized water (200 ml). The homogeneous solution was heated to 60 °C for recrystallization. A white powder was obtained by the subsequent evaporation of water. Then the precursors were heated with at 5°C·min$^{-1}$ to 900 °C and kept for 120 min under N$_2$ atmosphere.
REFERENCES

