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Geochemical parameters of naturally occurring solid hydrocarbons and implications for their use in lithium metal batteries

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The global transition away from fossil fuel energy resources necessitates the development of novel technologies, which has fostered rapid advances in Lithium-ion batteries. Lithium (Li) metal has shown good performance as an anode material in Li-ion batteries, but the formation of Li dendrites on the anode surface during charging cycles can result in both lowered battery performance and increased fire risk. Wang et al. (2017) recently demonstrated that a porous carbon material produced from gilsonite (a naturally occurring solid hydrocarbon) was a relatively inexpensive and effective substrate for Li plating in Li-metal batteries that reduced problems associated with dendrite formation. However, no geochemical information was provided on the gilsonite sample used, thus highlighting a knowledge gap around what solid hydrocarbon geochemical and/or microstructural parameters may be important when designing these batteries.

Here we present characterization data from a suite of six, naturally occurring solid hydrocarbons (including gilsonite) and from the porous carbon materials formed following the process of Jalilov et al. (2017) using each solid hydrocarbon as a starting material. The solid hydrocarbons originate from the Eocene Green River Formation in Utah and Cretaceous (mainly Torok Formation) outcrop samples from the Brooks Range foothills of Arctic Alaska. Data include elemental analysis (CHNOS), programed pyrolysis, Raman and infrared spectra, BET surface area, and electron microscopy. Evaluation of trends, or lack thereof, between solid hydrocarbon geochemical parameters and the generated porous carbon surface area (the most important parameter for Li plating) provides insight for selection of a solid hydrocarbon starting material when designing composite Li-metal anodes. We discuss these findings with perspective toward harnessing abundant, naturally occurring, geologic carbonaceous materials for the energy transition and underscore the importance of material characterization from a geologic standpoint for material science applications.

References

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