Like water for batteries

University of Pittsburgh

Pitt team finds water 'likeability' plays a role in battery-charged objects. Findings have implications for producing stronger, more durable batteries

PITTSBURGH—Objects made from graphite—such as lithium-ion batteries—are "hydrophobic," meaning that they "dislike" water. For decades this lack of likeability has presented significant challenges in terms of building more durable technological devices made with graphite—until now.

It appears that past samples of graphite were likely contaminated by air, causing the samples to appear hydrophobic, according to a University of Pittsburgh study. The Pitt team has demonstrated—for the first time—these materials are actually intrinsically attracted to water or "hydrophilic." The findings, published in Nature Materials, have particular implications for lithium-ion batteries and super capacitors, as both battery types are built from these materials.

"This work could change the fundamental understanding of the surface properties of these materials," said Lei Li, co-lead author of the paper and an assistant professor within Pitt's Swanson School of Engineering. "These findings hold implications for producing stronger, more durable batteries. And, hopefully, it will also be important to the fabrication of devices in various nanotechnology areas."

It was former undergraduate engineering student Rebecca McGinley (ENG '12) who noticed the inconsistent results regarding the surface's "wetting behavior" or its reaction to water, pushing the team to further investigate the strange phenomena. They found that, when graphite and graphene are exposed to air, a thin layer of hydrocarbon (a compound made entirely of hydrogen and carbon) quickly contaminated the surface. Using infrared spectroscopy and X-ray photoelectron spectroscopy, the team was able to "see" this hydrocarbon layer, noting its hydrophobic nature. However, when the team used heat to remove this contaminant layer, the surface became hydrophilic.

"Plastic and other types of materials emit hydrocarbon into the air," said Haitao Liu, co-lead author of the paper and an assistant professor in Pitt's Department of Chemistry within the Kenneth P. Dietrich School of Arts and Sciences. "And this hasn't been a factor in past sample experiments. In the past, the research community believed that graphite didn't 'like' water, possibly because their samples were always contaminated; the contamination happens typically within 10 minutes."

Liu and Li say this wettability could have an impact on how much energy can be stored within such devices that use lithium-ion batteries or super capacitors. The team will now conduct follow-up studies to understand the origins of their observations and study how controlling this wettability may impact some of the

applications of graphite (e.g. lubrication and energy storage).

In addition to McGinley, other collaborators from Li's engineering laboratory include Patrick Ireland (ENG '12), Andrew Kozbial (ENG '13), Yongjin Wang (ENG '13), and current undergraduate student Brittni Morganstein. From Liu's chemistry laboratory, graduate students Zhiting Li (A&S '13) and Feng Zhou (A&S '13) were involved as well as Ganesh Shenoy (A&S '13) and undergraduate chemistry student Alyssa Kunkle. Likewise, Pitt postdoctoral researcher in chemistry Sumedh Surwade assisted.
The paper, "Effect of airborne contaminants on the wettability of supported graphene and graphite," first appeared online July 21. This work was supported by Taiho Kogyo Tribology Research Foundation, Air Force Office of Scientific Research, Office of Naval Research, Pitt's Mascaro Center for Sustainable Innovation, Pitt's Central Research Development Fund, and the National Science Foundation.

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