Pumping up energy storage with metal oxides

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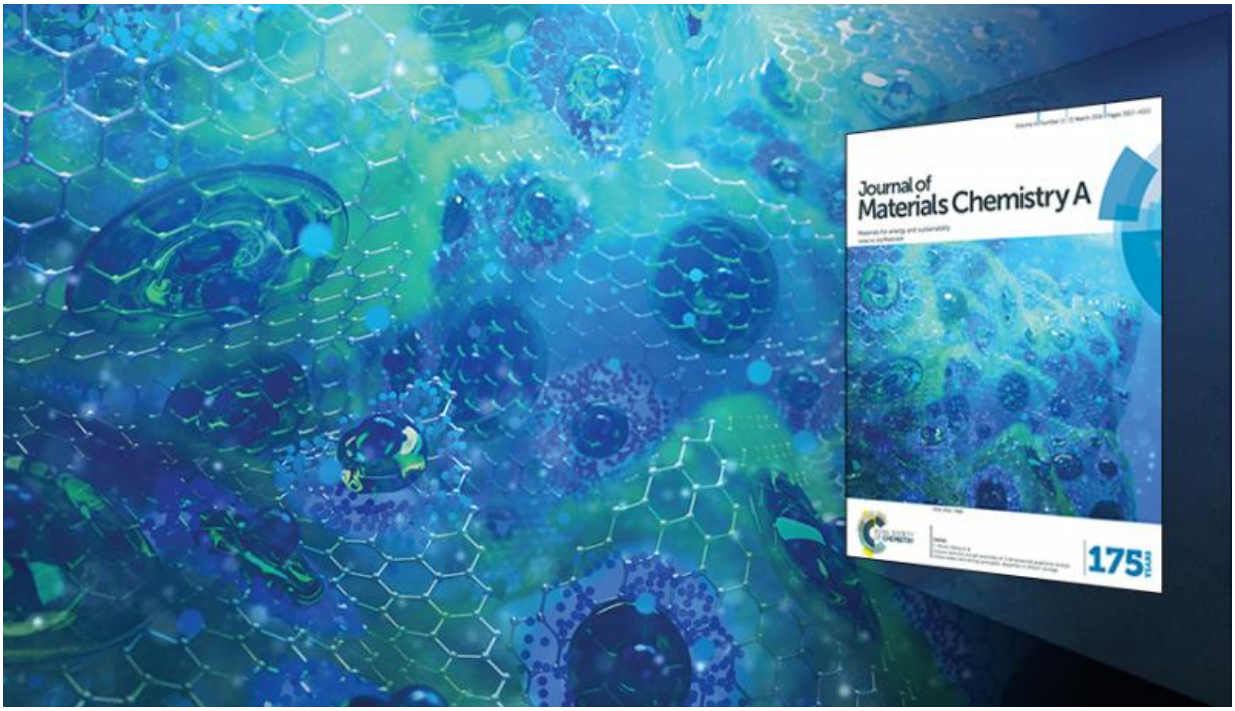

This schematic illustration shows metal oxides tented inside graphene. Many metal oxide/graphene composites offer unexpected capacity synergy that helps to increase storage capacity. Credit: Ryan Chen/LLNL.

Material scientists at Lawrence Livermore National Laboratory have found certain metal oxides increase capacity and improve cycling performance in lithium-ion batteries.

The team synthesized and compared the electrochemical performance of

three graphene metal oxide nanocomposites and found that two of them greatly improved reversible lithium storage capacity.

The research appears on the cover of the March 21 edition of the *Journal of Materials Chemistry A*.

Graphene-metal oxide (GMO) nanocomposites have become renowned for their potential in energy storage and conversion, including capacitors, lithium-ion batteries, catalysis (for fuel cells, water splitting and air cleaning) and sensors.

For applications in lithium-ion batteries, nanosized metal oxide (MO) particles and highly conductive graphene are considered beneficial for shortening lithium diffusion pathways and reducing polarization in the electrode, leading to enhanced performance.

In the experiments, the team dipped prefabricated graphene aerogel electrodes in metal ion solutions where all metal oxide nanoparticles appear to be anchored on the surface of graphene and are fully accessible to the electrolyte (i.e., open pore space).

"In essence, our approach helps to optimize the system-level performance by ensuring that most metal oxides are active," said LLNL material scientist Morris Wang and corresponding author of the paper.

The method can deposit most types of MOs onto the same prefabricated 3D graphene structure, allowing for direct comparison of electrochemical performance of a wide range of GMOs.

"We found that the experiments showed large reversible lithium storage capacities of graphene sheets, enabled by the unheralded roles of metal oxides," Wang said. "Surprisingly we saw the magnitude of capacity contributions from graphene is mainly determined by active materials

and the type of MO bound onto the graphene surface."

Specifically, the lithium storage mechanisms of MOs and their loading ratio versus graphene play key roles in determining graphene capacity contributions.

Provided by Lawrence Livermore National Laboratory