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Faculty of Chemistry SCHULICH

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אליהו פרבר

הפקולטה לכימיה ע"ש שוליך, הטכניון, חיפה

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בנושא:

"MOFs, Carbons, and Electrocatalysis: Tuning Porosity in Carbons"

❖ מחקר זה בוצע בהנחייתו של ד"ר דוד איזנברג.

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MOFs, Carbons, and Electrocatalysis: Tuning Porosity in Carbons

Porous carbons are key materials for many clean energy related technologies, including batteries, super-capacitors, fuel-cells, and more. Their porous structure enables mass transfer within the material and enhances the carbon's surface area. Combined with their natural conductivity, carbons are excellent electrocatalysts. However, in order to enhance their abilities even further, we would like to be able to design and tune the porous structure. Currently, many carbons are made by biomass or hydrocarbon pyrolysis, but this results in only a serendipitous porous structure. In contrast, methods for making well-defined and accurately tuned carbons suffer from low yields.

A promising alternative to serendipitous pyrolysis is the self-templating method. In self-templating, a precursor contains organic moieties, which will form the carbon backbone upon pyrolysis, and also inorganic moieties which will form distinct separate inorganic particles. The resulting particles are then removed via simple chemical processes and they leave a porous carbon behind whose properties are defined by the shape and size of the inorganic particles.

In my talk, I will present a homologous series of MOFs, utilizing the group II alkali earth metals, and I will illustrate the different structures obtained from each MOF. When different alkali earth containing MOFs are pyrolized, each forms different oxides, hydroxides, or carbonates, defining the shape and size of the pores. The resulting differences in the porous structure directly affect the behaviour of the carbons as electrocatalysts. Specifically, our research detected a difference in selectivity between the $2e^-$ and the $4e^-$ pathway, which we observed while investigating the structure-activity links of these materials using the oxygen reduction reaction. This showed how the catalysts structure causes confinement effects, directing the reaction towards one path or the other.

Additionally, for porous structures to be effective in terms of mass transfer and surface area, it is vital that the pores be connected. By creating a system where the number of pores can be controlled, we were able to observe different levels of pore connectivity, and measure the corresponding surface area in each state. This led to an understanding of how porous networks form via a percolation phenomenon, which we further pursued using a computational model. By describing the link between surface area and pore connectivity, we are able to further the understanding of porous structures, and contribute to the design of future porous materials.