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New porous materials for disruptive electrocatalysis and Energy storage

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A key feature of the current transition from a fossil based energy system to a carbon neutral, fully sustainable mode of operation is energy conversion and storage. EU countries are leaders in the field of Sustainable Energy Generation, but its intermittent Nature without novel storage will restrict its relative contribution to about 50 %, taken Germany as a typical case. This is why energy-to-chemicals schemes ("electrocatalysis") or fundamentally new, denser and more affordable electron storage devices are eagerly needed.

I will report in this presentation first on new, noble Carbons and COF-like, ionic Carbon Nitrides with extreme stability, showing HOMO potentials down to +2.7 Volt. These systems directly enable cocatalyst-free new electrocatalysis and new electrode constructions. Due to the positive work-function the new versions are remarkably suitable for single atom deposition and thereby represent a key step to extend the electronegativity and reactivity range of known metals ("making Ni to act as Pd"). Here I report on direct H_2O_2 synthesis and methane mono-oxidation enabled as such.

In electric energy storage, I will present the use of these systems for new, save metal anodes, for solid-state sulphur cathodes. If time allows, I will also report on a new, record breaking "Nitrogen-battery", where we ideally can store 8 electrons per nitrogen atom.