Chemical imaging of (electro)chemical processes in MXene down to single flakes

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Two dimensional transition metal carbide, called MXenes, are an ideal platform to explore water and ions in 2D confinement due to their tunable interlayer spacing and hydrophilic surface. Confined water, protons and ions may have fundamentally different properties in terms of hydration, diffusion and reactivity while being confined in sub-nm interlayer spacing of MXenes. These properties will have a major impact on applications for electrochemical energy storage, electrocatalysts and filtration among other applications. However, the nature of the confined species and their interaction with the MXene surface remains largely unexplored.

In this seminar, I will discuss the nature of confined chemical species in $Ti_3C_2T_x$ MXene interlayers and how they impact the surface chemistry of the MXenes using X-ray microscopy. With synchrotron-based *in situ* X-ray spectromicroscopy, enabling X-ray absorption spectroscopy with sub-50 nm spatial resolution,[1] the intercalated species can be imaged at the single MXene flake level.[2] The electronic signature of water confined in the MXene interlayer as a function of temperature will be discussed in more details.[3] I will also introduce *in situ* electrochemical X-ray imaging to monitor faradaic reactions in MXenes.[4]

Finally, I will show that imaging ellipsometry is another technique that enables the characterization of structural and electronic properties of MXene single flakes,[5] making this technique very promising for the optical imaging of MXene-based devices.

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References

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