Modifying the surface of 2D MXenes with organic macromolecules - a simple way to control their colloidal properties

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Tailoring the surface properties of various types of nanomaterials is highly challenging. The lack of understanding of underlined mechanisms of interaction also hinders the development of macromolecular layers deposition methods which should occur in a controllable manner, especially toward bio-related applications.

Recently, A new family of two-dimensional (2D) materials has been described and named MXene phases: carbides and/or nitrides of early transition metals. The name MXene also comes from their stoichiometry $M_{n+1}X_n$, where M is an early transition metal and X is carbon and/or nitrogen. MXenes are obtained by selective etching of A atomic layer from their parental ceramic phases – the MAX phases [1]. While A can be any element from groups no. 13-14 of the periodic table of elements, aluminium appears in the majority of etchable MAX phases.

Since MXenes' discovery, they become an attractive material for many applications as well as an outstanding model 2D material, especially in terms of surface chemistry and properties. Notably, MXenes' highly negative surface potential and exceptional stability in a water-based environment make them perfect candidates for mechanistic studies, including interactions with biologically active macromolecules and associated stability issues.

Our recent work [2] presents a comprehensive study on understanding the mechanisms driving MXene's surface modification with a model cationic protein – collagen. Subtle changes in the surface properties of 2D Ti_3C_2 and Ti_2C flakes were tracked *in situ* using DLS method and zeta potential during *step-by-step* adsorption of collagen monolayer from water dispersion. The colloidal properties and stability of chosen MXenes in a testing environment were also pH-dependent.

The presented study opens new avenues for designing surface-modified MXenes and paves the way for their future successful management in various applications. It also advances understanding of 2D materials' surface properties, which is essential for potential application in, e.g. nanomedicine, sensing or self-assembly approaches.

[1] M. Naguib et al., ACS Nano **6**,1322, (2012).

[2] A. Rozmysłowska-Wojciechowska et al,. Mater. Sci. Eng:C **111**, 110790, (2020)

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