SYNTHESIS AND BIOMEDICAL APPLICATIONS OF 2D CARBIDES (MXENES)

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Two-dimensional (2D) materials with a thickness of a few nanometers or less can be used as single sheets due to their unique properties or as building blocks, to assemble a variety of structures. The family of two-dimensional (2D) transition metal carbides and nitrides, MXenes, has been expanding rapidly since the discovery of Ti_3C_2 in 2011 [1]. More than 20 different MXenes have been synthesized, and the structure and properties of numerous other MXenes have been predicted using density functional theory calculations [2]. MXenes' versatile chemistry renders their properties tunable for a large variety of applications. Oxygen or OH terminated MXenes, such as $Ti_3C_2O_2$, are promising candidates for biomedical applications [2].

Antibacterial properties of micrometer-thick titanium carbide ($Ti_3C_2T_x$) MXene membranes prepared by filtration on a polyvinylidene fluoride (PVDF) support have been studied. The bactericidal properties of $Ti_3C_2T_x$ modified membranes were tested against Escherichia coli and Bacillus subtilis. The demonstrated antibacterial activity of MXene coated membranes against common waterborne bacteria, promotes their potential application as anti-biofouling membrane in water and wastewater treatment processes, as well as a bactericidal coating. [3] The 2D titanium carbide sheets manifest strong optical absorption in the near-infrared (NIR) around 800 nm. The performance of this material is comparable or even superior to that of state-of-the-art photoabsorption materials, including gold-based nanostructures, carbon nanomaterials, and transition-metal dichalcogenides. Preliminary studies show that the titanium carbide sheets serve as an efficient photothermal agent against tumor cells. [4]

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