Plasma Jet Printing and in Situ oxidation of Mxene surfaces

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We developed an innovative approach to print TiO_2-Ti_2C MXene heterostructures with promising applications in photocatalysis. Leveraging a low-powered atmospheric pressure plasma jet (APPJ) for in situ oxidation of Ti_2C MXene provides a controlled and energy-efficient route to forming TiO_2 layers with tailored electronic and structural properties. The in-situ oxidation method using APPJ promotes the formation of defect-rich TiO_2 on the Ti_2C substrate, which can enhance photocatalytic performance due to improved light absorption and charge separation. The creation of vacancies and mixed oxidation states of Ti and C likely contributes to a broadening of the absorption spectrum and facilitates electron mobility, crucial for efficient photocatalysis. The introduction of vacancies and the variation in valence states of titanium and carbon enhances the electronic density of states near the Fermi level. This modification may improve the MXenes catalytic efficiency by reducing electron-hole recombination rates and enabling more effective charge transfer.

The use of APPJ not only enables in situ oxidation but also offers flexibility for surface functionalization, which is advantageous for tailoring the photocatalytic properties to specific applications. Additionally, APPJ's potential in printing and depositing these materials on diverse substrates can open new avenues in device integration and scalability. These TiO_2-Ti_2C MXene heterostructure shows promise for thin-film photocatalytic electrodes, which could be useful in environmental and energy-related applications, such as wastewater treatment and hydrogen production. Its deployment versatility could also extend to other photocatalytic and optoelectronic uses.

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