MXenes application in microelectronics (MXetronics)

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MXenes are a family of emerging two-dimensional (2D) materials composed of atomic-thin early transition metal carbides and nitrides. Their unique properties, such as excellent conductivity, surface plasmons, hydrophilicity, tunable surface groups and work function (theoretically in between 2 and 8 eV), and good water dispersibility without surfactant. Such abundant properties together with the large compositional variety make them attracitve to design MXene-based microelectronics with novel functionalities. Our research efforts recently are heavily focused on the application of MXenes and their derived materials in the field of integrated transistor circuits. We demonstrated that $Ti_3C_2T_x$ MXene films and V_2CT_x-derived Metal organic framework (V_2CT_x-MOF) films can be reliably processed through the industry compatible nanofabrication patterning process. Using patterned $Ti_3C_2T_x$ MXene films as source/drain/gate metal electrode, we were able to fabricate the lab-made ultrathin $Ti_3C_2T_x$ –MoS_2 circuits with a high yield and a low performance variability. We have also fabricated the first 2D MOF-MoS_2 electron-double-layer transistor (EDLTs) using patterned V_2CT_x-MOF films as the solid electrolyte. Furthermore, when replacing the traditional metal Au/Ni with a $Ti_3C_2T_x$ MXene film as the schotcky gate electrode to control the 2D electron gas (2DEG) in the GaN high-electron-mobility transistor (HEMT), we observed an incredible performance enhancement. The remarkable results obtained so far using MXenes in microelectronics suggest a bright future for MXetronics.

References

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Figures

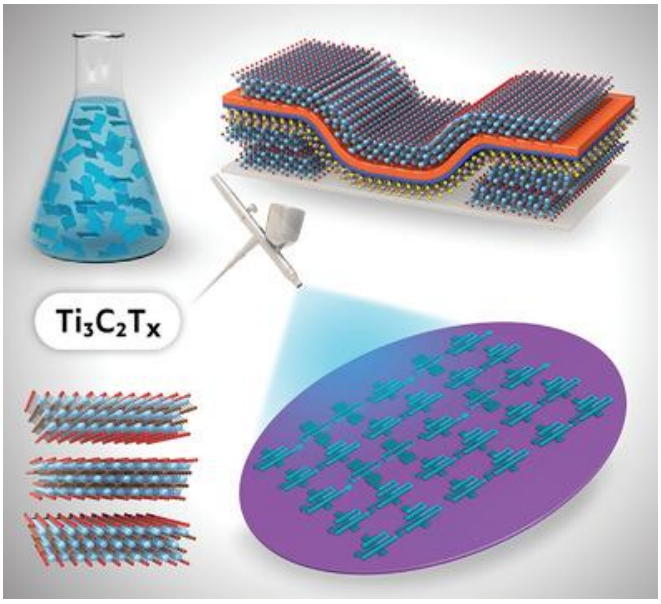

Figure 1: $Ti_3C_2T_x$ MXene in wafer-scale integrated 2D electronics