Secondary-ion mass spectrometry evaluation of MAX and MXene production approaches

Paweł Piotr Michałowski[1]
Mark Anayee[2], Robert Lord[2], Iryna Roslyk[2], Sylwia Kozdra[1], Adrianna Wójcik[1,3], Yury Gogotsi[2]
[1] *Łukasiewicz Research Network - Institute of Microelectronics and Photonics, Aleja Lotników 32/46, 02-668 Warsaw, Poland*
[2] *A.J. Drexel Nanomaterials Institute and Department of Materials Science and Engineering, Drexel University, Philadelphia, Pennsylvania 19104, United States*
[3] *Faculty of Physics, Warsaw University of Technology, Koszykowa 75, 00-662 Warsaw, Poland*
Pawel.Michalowski@imif.lukasiewicz.gov.pl

With recent development in secondary-ion mass spectrometry (SIMS) instrumentation complemented by establishing dedicated measurement procedures – tailored for specific samples – it is possible to push the boundaries of SIMS analyses and reach atomic depth resolution.

SIMS measurements of the MAX phase and resulting MXene samples produced using a conventional process reveal that oxygen atoms are incorporated in the carbon sites. Thus, they should be considered as early transition metal oxycarbides and not carbides as it is commonly assumed [1]. However, modification of the production procedure [2,3] may lead to the formation of pure carbide materials. The outcome can be evaluated with the SIMS technique which can unambiguously detect and identify all elements, starting with hydrogen, with atomic depth resolution, atomic layer by atomic layer. Such precision may prove invaluable for further developing MAX and MXenes and other 2D materials.

References

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[3] Iqbal, A., Small Methods (2023), 2201715

Figures

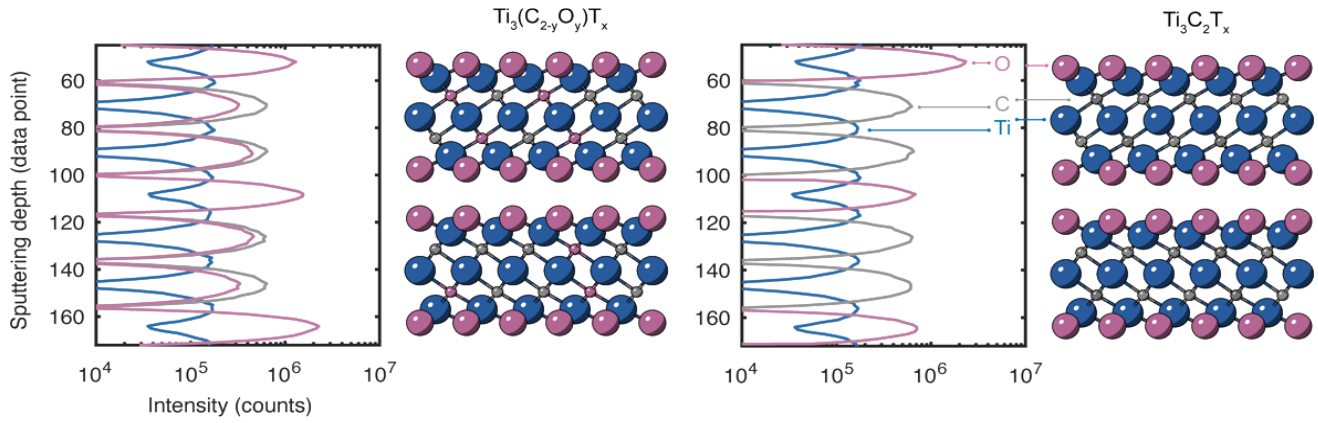

Figure 1: SIMS depth profiles of multilayer Ti3C2Tx MXene samples. Samples produced with conventional processes (left) show significant levels of oxygen in the carbon layer, qualifying them as oxycarbides. Pure carbides can be obtained with modified production procedures (right).