

Developing a model catalyst system for investigating metal-support-interaction in Fischer-Tropsch synthesis

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Oxide-supported transition metals like cobalt, iron, nickel, and ruthenium are highly active catalysts for Fischer Tropsch synthesis (FTS). Metal-support interactions (MSI) play a crucial role in the activity and stability of the catalyst.^[1] For instance, strong MSI at the Co/TiO₂ interface can lead to encapsulation of cobalt under a TiO_x layer, resulting in catalyst deactivation.^[2]

To systematically investigate MSI in cobalt-based catalysts, we prepared planar model catalysts by depositing support materials (Al₂O₃ and TiO₂), onto RCA-oxidized Si wafers using atomic layer deposition (ALD), followed by cobalt deposition via e-beam evaporation. Characterization using X-ray photoelectron spectroscopy (XPS) and near-edge X-ray absorption fine structure (NEXAFS) revealed differences in the electronic and local-bonding structures of ultrathin (<1 ML) TiO₂ and bulk-like thicker TiO₂ films. Additionally, we observed interfacial mixing between the various oxides upon annealing.

Based on these findings, we further investigated how MSI evolves with varying support thickness and oxide composition. We will report on the resulting changes in cobalt's electronic structure and its implication for tailoring MSI in the supported catalyst systems.

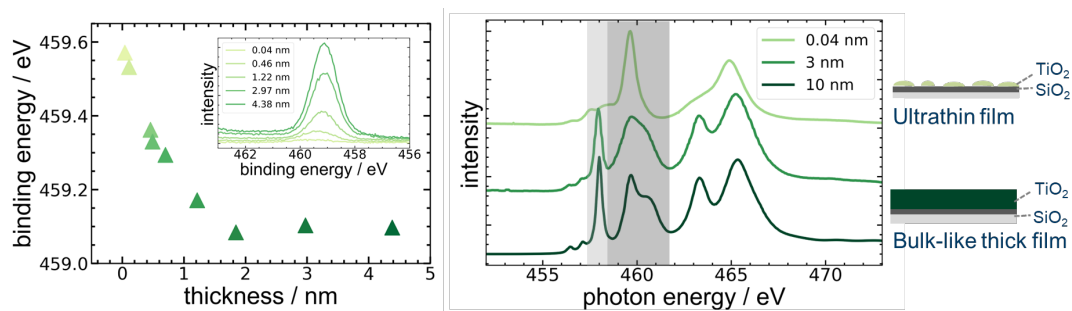


Figure 1 Left: Binding energy of the 2p_{3/2} level for Ti⁴⁺ at varying TiO₂ film thickness on a Si substrate covered with SiO₂. The inset shows the Ti 2p_{3/2} peak profiles. Right: NEXAFS spectra of the Ti L-edge from TiO₂ films on the same substrate, with the grey area highlighting differences in the Ti L₃-edge.

References:

- [1] Leybo, D., et al. *Chem. Soc. Rev.* **53**, 10450–10490 (2024).
- [2] De La Peña O'Shea, V. A. et al. *Chem. Commun.* **47**, 7131 (2011).