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Developing Self-Supported Metal Oxide Nanowire Catalysts for the Oxidative Coupling of Methane

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Progress of the research

The major goal of the proposed research is to elucidate the synergy between MnO_x and WO_x species in the oxidative coupling of methane (OCM). Our strategy involves the synthesis of MnO_x and WO_x nanowires (NWs) and further grafting of WO_x and MnO_x species via atomic layer deposition (ALD) and Surface Organometallic Chemistry (SOMC) approaches.

During the first year, one graduate student (4 months) and one undergraduate student (1 month) were assigned to this project. We completed our OCM reactor setup as proposed in our original proposal. The quartz reactor with an inserted thermocouple is able to test the OCM reaction up to 900°C. Our reactor setup is equipped with a Micro-GC which is able to quantify all the reactants and products (except H_2O) involved in the OCM reaction.

In order to test the reactor setup, we synthesized a Mn-Na_2WO_4/SiO_2 catalyst by incipient wetness impregnation method. Our impregnated catalyst shows very high catalytic performance in the OCM reaction. As shown in Figure 1, the highest C_{2+} product yield reaches 25% at 850°C, which agrees well with the literature data. This clearly demonstrates that our reactor setup meets our needs on OCM research.

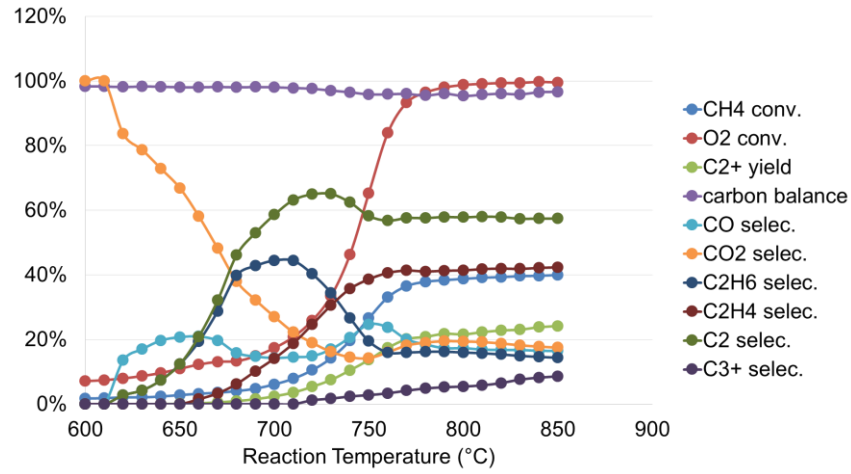

Figure 1. OCM catalytic performance of a standard Mn-Na_2WO_4/SiO_2 catalyst prepared by impregnation method.

Furthermore, we have successfully synthesized several types of metal oxide NWs, including MnO_2, WO_3, La_2O_3, Al_2O_3, and MgO. These NWs have diameters ranging from 10-50 nm. The morphologies are similar to those reported in the literature. However, the WO_3 NWs form bundles (Figure 2), which needs further optimization in synthesis.

We are currently working on surface modification of the MnO_2 and WO_3 NWs and plan to study their OCM performance.

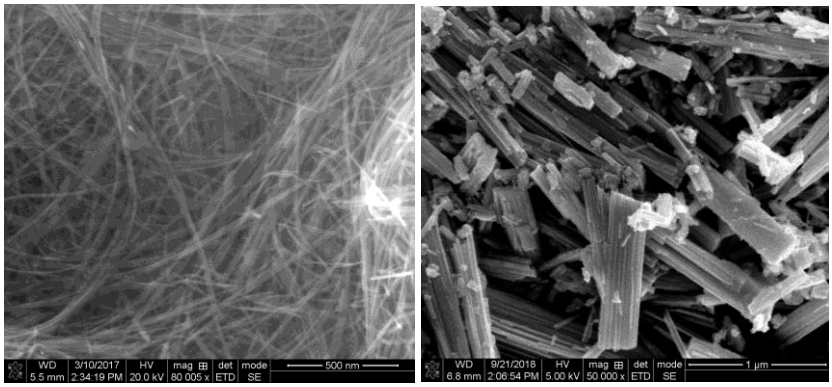

Figure 2. Scanning Electron Microscopic images of MnO_2 (left) and WO_3 (right) NWs synthesized in our lab. The scale bars are 500 nm and 1µm for MnO_2 and WO_3, respectively.

Impact of the research on PI's career

During the funding period, the PI was invited to give a talk in the 2017 Louisiana Gulf Coast Oil Exposition (LAGCOE) to discuss our research on natural gas catalytic conversions. The PI co-organized a natural gas catalysis symposium in the 2018 ACS spring meeting in New Orleans.