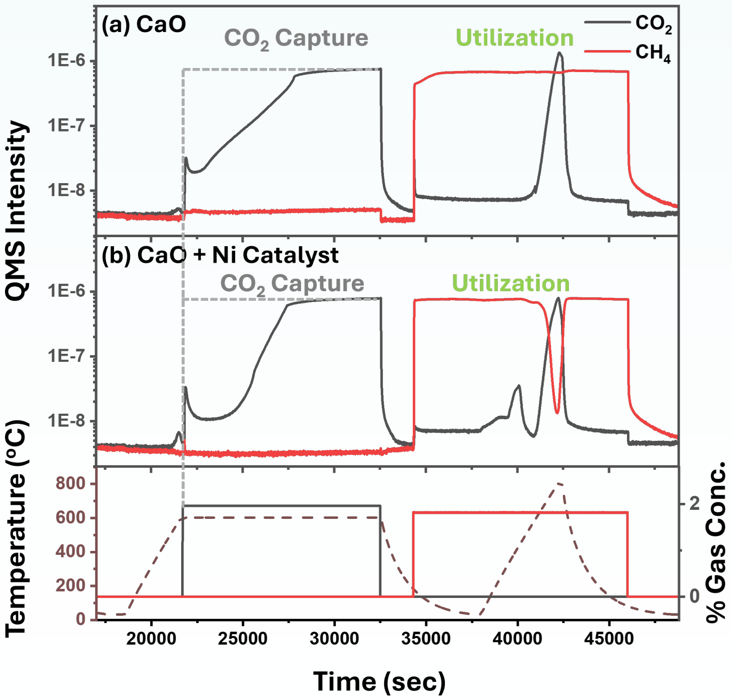
Application Note 3:

Recently, the integration of carbon capture and utilization (CCU) with DRM has attracted great attention. This integrated approach enhances the environmental benefits of DRM by capturing CO_2 emissions from other processes and using it as a feedstock in DRM, thus creating a closed-loop system that further reduces greenhouse gases.



QMS intensity profiles of CO_2 (44 amu) and CH_4 (15 amu) signals for (a) CaO, (b) CaO-NiHAP catalyst, and (c) temperature and gas concentration profiles during ICC-DRM experiments.

The ICC-DRM is one of the most recent experimental capabilities within the CCUS-1 setup. In this experiment, materials are initially exposed to a continuous flow of CO_2 until equilibrium saturation is achieved at the desired temperature. Users can effectively monitor the CO_2 capture process by analyzing the breakthrough curve, which allows for the calculation of the CO_2 quantity in mmol per gram of sorbent. (Step 1)

Subsequently, the procedure involves heating the material to 800°C with a linear ramp rate of 10°C per minute under a constant 2% CH_4 flow for utilization. This heating process facilitates the desorption of CO_2, which then reacts with CH_4 to produce syngas. (Step 2)

Figure (a) illustrates the ICC-DRM experiment conducted on CaO without the presence of a catalyst. During step 1, CaO effectively captures CO_2 at 600°C, followed by its release at approximately the same temperature, with a temperature peak around 700°C during step 2. Although this temperature range is ideal for the Dry Reforming of Methane (DRM) reaction, the absence of an appropriate catalyst prevents the conversion of CH_4.

In contrast, the introduction of a Ni catalyst to CaO, as depicted in Figure (b), results in the simultaneous desorption of captured CO_2 and a decrease in the CH_4 signal at a catalytically relevant temperature of approximately 700°C. This highlights the role of the catalyst in facilitating the DRM reaction.