Simple CaO-based materials for efficient CO_2 capture and utilisation

Chunfei Wu*
School of Chemistry and Chemical Engineering, Queen's University Belfast, Belfast, BT7 1NN, UK
Email: c.wu@qub.ac.uk

Carbon capture and utilisation (CCU) holds great potential to support carbon-intensive industries in their transition to Net Zero. State-of-the-art CCU focuses mainly on the independent development of CO_2 capture and utilisation technologies. Note that significant energy is also required for CO_2 storage and transportation. Hence, novel technologies are required to intensify CCU via the integrated CCU, i.e., ICCU, to reduce energy consumption. For example, it is reported that CaO-based materials can be used as the sorbent for CO_2 capture from flue gas and the catalyst as well for hydrogenation of the captured CO_2. The ICCU process showed excellent performance with high CO_2 conversions of >75%, which is hardly attainable by conventional CO_2 utilisation processes. Especially in the ICCU process, the high instant molar ratio of H_2 to CO_2 provides more thermodynamically favourable conditions to promote CO_2 conversion.

In particular, CaO can be used as both sorbent and catalyst for CO_2 capture and utilisation. For example, as shown in Figure 1, using simple CaO to capture CO_2 from simulated flue gas at around 600 ℃. After carbon capture, hydrogen was fed into the reactor to convert the captured CO_2 into CO at the same reaction temperature. This new process is significantly simplified compared to conventional techniques, since it removes the transfer of sorbent, avoids the requirement of a higher temperature for sorbent regeneration, and eliminates the transfer of CO_2 prior to its utilisation. Moreover, a high CO_2 conversion rate of up to 80% was reported with ca. 100% selectivity to CO. The researchers also found that using N_2 instead of H_2 released a similar amount of CO_2 during the sorbent regeneration or CO_2 conversion stage, indicating that the direct hydrogenation of $CaCO_3$ should be the main factor contributing to the higher conversion of the captured CO_2 using just CaO.

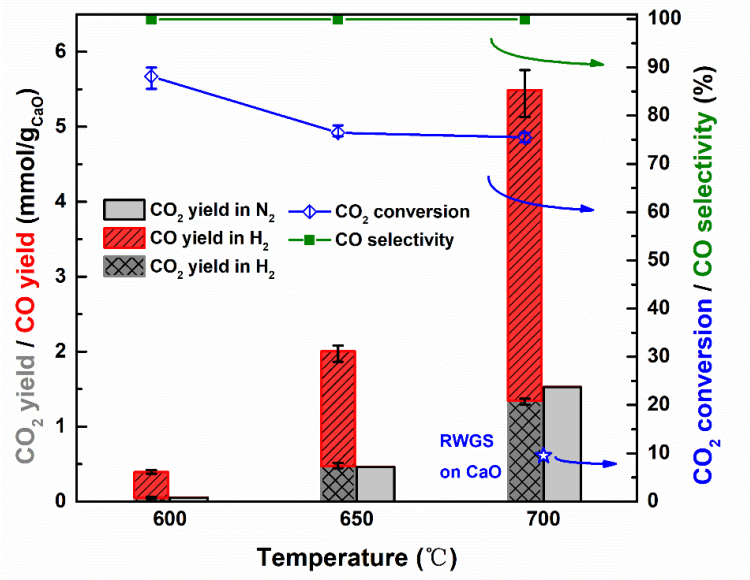

Figure 1. The yield, conversion and selectivity of CO_2 and CO over isothermal CaL in H_2. (RWGS on CaO: H_2/CO_2=4:1, T= 700 ºC, cat.= 5.0g CaO)