Researchers propose titanium-based perovskite for water activation and lower-temperature hydrolysis of organic sulfur

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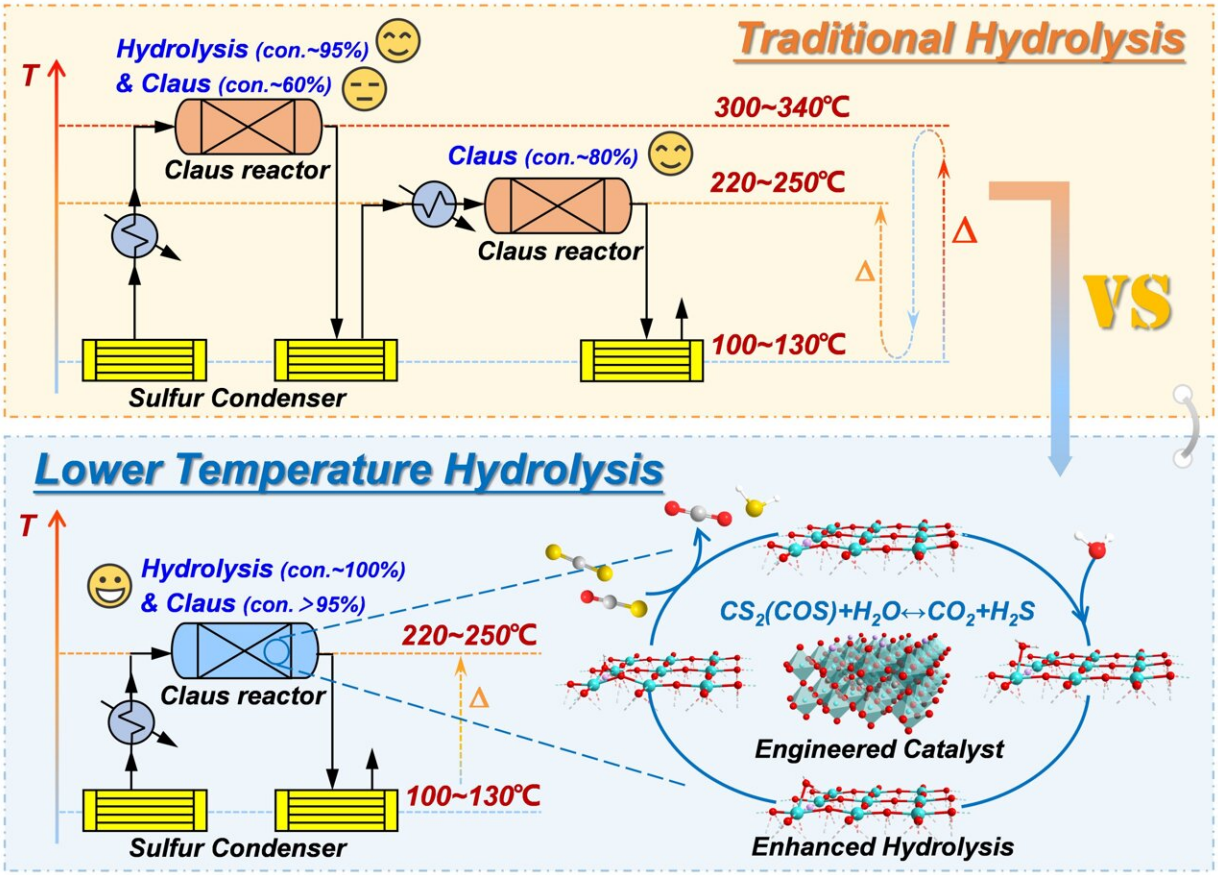

A schematic illustration for the comparison of traditional and novel operation process. Credit: UCAS

According to a study published in *Proceedings of the National Academy of Sciences* on Jan. 11, researchers led by Prof. Hao Zhengping from the University of Chinese Academy of Sciences (UCAS) have proposed facile oxygen vacancy (V_O) engineering on titanium-based perovskite to motivate water (H_2O) activation, achieving enhanced organic sulfur hydrolysis and efficient sulfur recovery at lower temperatures.

Water activation is involved in many reactions and processes. Organic sulfur (COS and CS_2) hydrolysis is one such typical reaction using the H_2O molecule as a reactant. In industrial sulfur recovery processes, an additional hydrolysis catalyst is installed in the first stage of the Claus reactor to convert COS and CS_2. Limited by the effective activation of water, relatively higher temperatures are required for the hydrolysis of CS_2 in a complex environment, which is not conducive to the sulfur recovery reaction, and thus severely affects the sulfur recovery efficiency and pollution emission control of the Claus process.

In this study, the researchers fabricated titanium-based perovskites with different V_O contents, and found that there was a linear correlation between the V_O content and the degree of H_2O dissociation and hydrolysis performance. The low-coordinated Ti ions adjacent to V_O were active sites for H_2O activation.

The introduction of V_O, especially V_O clusters, resulted in the reduction of the energy barrier for H_2O dissociation, which contributed to H_2O activation and dissociation, according to the researchers.

Furthermore, their in-depth mechanism study revealed that CS_2 hydrolysis was initiated from the reaction between dissociatively adsorbed -OH and gaseous CS_2 (Eley-Rideal mechanism), which was the origin of the enhanced hydrolysis activity from the enhanced H_2O activation by V_O.

Consequently, complete conversion of COS and CS_2 was achieved over $SrTiO_3$ after H_2 reduction treatment at 225°C, a favorable temperature for the Claus conversion. Surprisingly, the catalyst also showed excellent Claus catalytic activity.

Thus, both efficient organic sulfur hydrolysis performance and improved sulfur recovery efficiency can be achieved simultaneously. The application of this dual-functional catalyst can significantly improve the sulfur recovery efficiency, simplify the operation process and reduce the investment and operational cost.

Prof. Hao's team has long been engaged in the research and development of acid gas pollution control and resource recovery and utilization. They have an in-depth understanding of acid gas emission reduction and control. The production and publication of the results are based on the team's work over many years and are of great significance to the emission reduction control, resource recovery and utilization of acid gas.

More information: Zheng Wei et al, Oxygen vacancy-engineered titanium-based perovskite for boosting H 2 O activation and lower-temperature hydrolysis of organic sulfur, *Proceedings of the National Academy of Sciences* (2023). DOI: 10.1073/pnas.2217148120

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