Research Highlights

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On/Off Boundary of Photocatalytic Activity between Single- and Bilayer MoS_2

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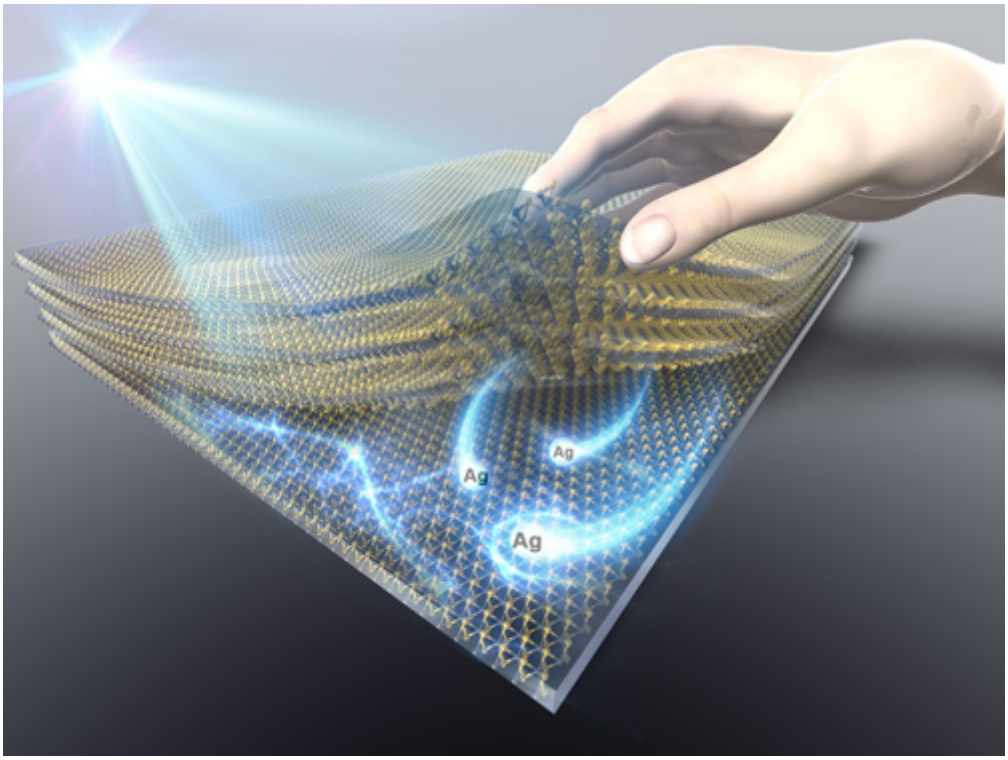
A team at WPI-MANA has succeeded in spatially resolving the photocatalytic activity of molybdenum disulfide (MoS_2) as a model catalyst. The findings advance our understanding of the potential photocatalytic activity of 2D nanophotocatalysts.



Molecularly thin two-dimensional semiconductors are attracting interest as photocatalysts thanks to their layer-number-dependent quantum effects and high charge separation efficiency.

However, the correlation among the dimensionality, crystallinity and photocatalytic activity of such 2D nanomaterials remains unclear. The team used a silver (Ag) photoreduction technique coupled with microscopic analyses to spatially resolve the photocatalytic activity of MoS_2 as a model catalyst.
They found that only monolayer (1L)-MoS_2 is active for Ag photoreduction reactions. The photocatalytic activity of 1L-MoS_2 is enhanced by a built-in electrical field originated from the MoS_2SiO_2 interface, rather than by the specific surface structure and quantum electronic state of 1L-MoS_2.

The team discovered that photocatalytically active sites were geometrically distributed on triangular 1L-MoS_2 crystals, in which the Ag particles are preferentially deposited on the outermost zigzag edges and defective inner parts of the triangular grains. The degradation of photocatalytic

activity and electron mobility with the formation of Mo(VI) species indicates that the species inhibit the in-plane diffusion of the photogenerated electrons to the reductive sites.

MoS_2 was chosen for the study because it is a useful sunlight-driven photocatalyst. There has been considerable effort recently toward the development of MoS_2-based photocatalysts for various reactions including water splitting, CO_2 reduction and bacteria inactivation.

The study provides insights into these critical aspects to guide a general design strategy to reveal the potential photocatalytic activity of 2D nanomaterials. The monolayer selectivity, activation and inactivation mechanisms in 1L-MoS_2 suggest future directions in designing 2D nanophotocatalysts.

This research was carried out by Takaaki Taniguchi (Senior Researcher, Functional Nanomaterials Group) and his collaborators.

Reference

"On/Off Boundary of Photocatalytic Activity between Single- and Bilayer MoS_2"
Takaaki Taniguchi, Leanddas Nurdiwijayanto, Shisheng Li, Hong En Lim, Yasumitsu Miyata, Xueyi Lu, Renzhi Ma, Dang-Ming Tang, Shigenori Ueda, Kazuhito Tsukagoshi, Takayoshi Sasaki and Minoru Osada
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