# Utilizing 2D materials for sustainable energy

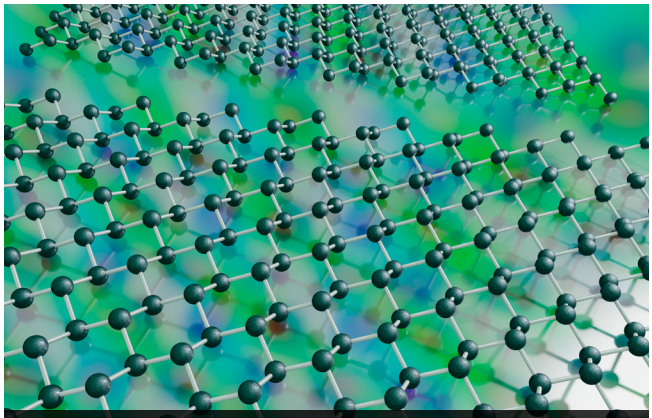
Engineering 2D materials brings NEW POSSIBILITIES TO ENERGY SYSTEMS.

**A team led by Yi Xie** is exploring the potential of 2D materials to change how we harness energy using photocatalytic and electrocatalytic reactions, and thermoelectric conversion, among other things.

"In 2016, we proposed that energy conversion could be optimized via defects in the electron and phonon structures of very thin, or 2D, semiconductors," explains Xie. "These can activate more than one physical parameter, known as a 'degree of freedom', giving materials useful properties."

For example, they have demonstrated that efficient interlayer charge release caused by dual vacancy defects and codoping can increase carrier concentration, thereby achieving high thermoelectric performance in BiCuSeO.

In a 2016 *Nature* paper, surface defects in nanosheets of partially-oxidized cobalt atoms were shown to be more likely to lead to methanol production from carbon dioxide at a manageable overpotential, the negative potential required to activate electroreduction.



Yi Xie is exploring how defects in very thin materials can efficiently harness energy.

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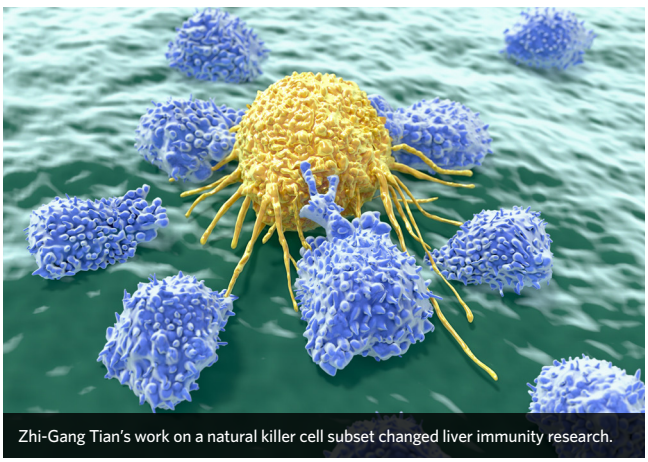
Furthermore, they have found that the surface potholes of a tungsten trioxide nanosheet easily excited high momentum electrons to achieve photocatalytic nitrate synthesis directly from nitrogen at room temperature.

The team are also using excitons to improve photocatalysis. They showed the thinness of a low-dimensional black phosphorus semiconductor affected its exciton binding energy gap, widening its light absorption spectrum, improving efficient catalysis.

The latter could also be achieved, says Xie, through promoting the dissociation of excitons into uncorrelated electrons and holes, and in the heterojunctions between low-dimensional photocatalysts and noble metal particles. ■

# The liver's killer instincts

Insights on natural killer cells in the liver bring potential NEW TREATMENTS FOR DISEASE.



Zhi-Gang Tian's work on a natural killer cell subset changed liver immunity research.

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**The discovery of a unique** subset of natural killer (NK) cells in the liver by Zhi-Gang Tian and his colleagues changed immunology of the organ.

Finding that the liver is enriched with a range of innate immune cells, including NK cells, led to recognition of the liver as an organ with predominant innate immunity, explains Tian.

In 2013, Tian's group discovered a unique NK cell subset in the liver that helped explain why many viruses cause lifelong liver-specific infections. "Targeting liver-resident NK cells or their surface immune-regulatory molecules might provide therapeutic options for chronic liver disease," he says.

Work published in *Science* in 2021 by Tian's group has also changed views on the generation site of NK cells. They showed that the adult liver contained hematopoietic stem cells derived from the fetal liver, which could develop into liver-resident NK cells.

In the last few years the group has focused on maximizing NK cell-mediated anti-tumour activity and improving current cancer chemotherapy, while insights have also been gleaned on the mechanisms of chronic viral hepatitis and hepatocellular carcinoma.

"These findings should encourage researchers to study tissue-specific NK cell subsets in other tissue or organs, and their roles in other organ-specific disease," says Tian. ■