A glowing gathering in the limelight

Studies on novel materials at the INSTITUTE OF MOLECULAR AGGREGATION SCIENCE AT TIANJIN UNIVERSITY are set to start a revolution.

Fluorescent sensors are powerful tools for a wide range of uses, from environmental monitoring to biological research and clinical diagnosis. Higher emission efficiency and stronger photo-stability can be achieved using a special group of organic molecules that fluoresce only when they aggregate.

Such aggregation-induced emission (AIE) materials were reported in 2001 and given the name AIE, by Tang Benzhong, the honorary dean of Institute of Molecular Aggregation Science at Tianjin University, who was then a researcher at the Hong Kong University of Science and Technology.

Organic compounds typically show higher photoemission efficiencies in solution than in the solid state. When molecules aggregate, such as in highly concentrated solutions or the solid state, their luminescent properties tend to diminish, a phenomenon known as aggregation-caused quenching (ACQ). The ACQ effect has significantly hampered the design of luminescent materials, so great effort has gone into countering it.

The AIE phenomenon, where light emission is enhanced when organic molecules are packed, has opened a new avenue for luminescent material development

In nearly 20 years studying AIE materials, Tang and his team have unveiled the mechanism of AIE. "The restriction of intramolecular motions generally explains its working mechanism," says Tang. The study of AIE systems allows the aggregate process to be put to use, rather than being resisted, he explains. Their ability to fluoresce gives AIE materials potential for real-time monitoring, optoelectronic devices, mechanochromism inks and much more.

The most exciting fields for AIE materials are in life sciences and biomedical research, such as photo-imaging of biological structures and bioprocesses.

The AIE research also opens a new field of interdisciplinary research that will progress the development of chemistry, physics, biology, and medicine. It is estimated that 4,500-plus research institutions in more than 80 countries and regions are now engaged in AIE research. Their published papers have attracted more than 100,000 citations, and the number of SCI papers published on AIE exceeds 1,000 each year. AIE materials are considered one of the four nanomaterial systems supporting the upcoming 'nanolight revolution'.

Tang's research on AIE won the first prize of China's National Natural Science Award in 2017. "From atoms to molecules, and to molecular aggregates, the AIE chemistry and related scientific disciplines continue to advance," says Tang. "So far, molecular aggregation and related research is definitely at the forefront, with significant theoretical and application values."

In light of the booming AIE research and the progress of molecular aggregation science, Tianjin University established the Institute of Molecular Aggregation Science in 2018, opening a new chapter of interdisciplinary research on materials, environment, and biomedical sciences.

As the world's first research centre named for its strength in molecular aggregation science, its research is not limited to AIE molecules, but also focuses on exploring the properties of molecular aggregates and their underlining mechanisms.

To encourage inter-disciplinary research, the institute will cultivate talent, and explore new scientific phenomena and principles to develop highly sensitive and easy-to-operate tools.

Its establishment has far-reaching significance for promoting the development of the field of chemistry. ■

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