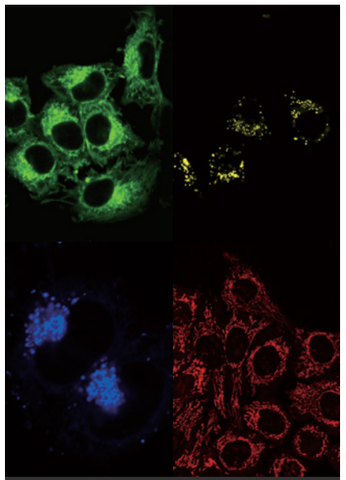
ADVERTISEMENT FEATURE

A clear view of a bright future

Exploiting unique materials featuring AGGREGATION-INDUCED EMISSION characteristics, the new AIE Institute in Guangzhou seeks to solve key scientific problems, and drive regional development.

AIE Institute was launched in May 2020.



Diverse applications of AIE dots for high-resolution biological imaging

Like climbing a mountain of knowledge, diverse new theories and products have emerged over almost 20 years of AIE research.

The use of nanomaterials and devices in medicine has shown great promise for personalized diagnosis, imaging, and therapy. One example is the emergence of aggregation-induced emission (AIE) nanoparticles as a useful bioimaging tool, particularly for the early detection of cancers.

It began in 2001 with the coinage of the concept of AIE by Ben Zhong Tang, who is now director of AIE Institute in Guangzhou and professor at South China University of Technology and The Hong Kong University of Science and Technology, China. Tang found that a series of silole derivatives displayed no or weak photoluminescence when in good solvents, but they glowed when in concentrated solutions or as a solid. Intrigued, his team has since applied AIE findings to different functional materials.

"We foresee unlimited possibilities for AIE research," says Tang. "It has major industry applications, bringing us real-world benefits."

Opening up a new field

Conventional understanding suggests that when molecules aggregate, their luminescent properties tend to diminish, a phenomenon known as aggregation-caused quenching (ACQ). This effect has hampered the design of luminescent materials as researchers struggle to find materials enabling high emission efficiency and strong photostability in the aggregate and solid states.

Tang's team challenged this accepted thought. Their experiments revealed that in dilute solutions, the luminogens underwent dynamic intramolecular motions, which made them lose their excited energy non-radiatively, and become non-luminescent. But when in an aggregate state, the intramolecular motions were restricted by their molecular packing, blocking the non-radiative pathway, making the molecules emissive.

Almost two decades since the coinage of the concept, more than 145 countries and regions all over the world have contributed to AIE research, representing fields ranging from chemistry and materials science, to biology and life sciences.

Based on the understanding of AIE mechanism, Tang's team has synthesized a large number of luminogens to enable new AIE systems for use in optoelectronics, chemosensing, and bioimaging.

Revolutionizing bioimaging technology and beyond

For Tang, the application of AIE technology has been of vital significance in biomedicine. One key innovation is the use of AIE luminogens (AIEgens) for non-invasive cell tracing. From monitoring tissue regeneration after stem cell transplantation, to tracking carcinogenesis and cancer progression, observing biological processes over time requires *in vivo* luminescence imaging. Tang's team has devised new strategies to overcome the limitations of existing probes.

One of the few bioprobes currently used for this kind of non-invasive fluorescence microscopy is the green fluorescent protein (GFP). First discovered in a type of jellyfish, GFP can be fused with other proteins to allow their visualization in living cells, without affecting cell or tissue functions. It provides high spatiotemporal resolution when tracking the target protein's changes, enabling the study of molecular activity in detail. However, probes based on GFP are expensive, and limited in variety.

A renowned pioneer, Ben Zhong Tang is director of AIE Institute.

Tang's organic AIE probes possess high emission efficiency, great absorptivity, excellent biocompatibility, and strong photobleaching resistance for continuous monitoring of biological processes *in vitro* and *in vivo*. Research over the years has led to more targeted imaging, which can benefit surgery. For instance, Tang contributed to the use of the AIEgens in vascular imaging by aurologist. Delicate small veins can be well illuminated, which helps avoid surgical errors.

Tang also described the use of an AIEgen-based theranostic system, which combines multimodality imaging and photodynamic therapy. In this system, the AIEgens emit strongly, allowing for clearer imaging for cancer detection. Precise molecular engineering enables these AIEgens to be designed into high-performance photosensitizers and photothermal agents, which have potential to overcome the drawbacks of conventional photosensitizers, including poor photostability, nonspecific targeting, and poor tissue penetration depth. With high loading, these AIE nanoparticles (AIE dots) offer brightness for imaging, and high temperature to kill cancer cells with minimal damage to surrounding healthy tissues.

Apart from bioprobes for imaging, diagnosis and treatment, Tang's team has also been working on AIEgen-based advanced smart materials for stimuli response and sensing, as well as organic light emitting diodes (OLEDs) for display and lighting. Looking to nature for inspiration to investigate OLED fabrication, their latest work seeks to improve the fabrication technologies for thin film, ink, micro-nano processing, and large-area printing display.

Many of these proof-of-concept demonstrations in the laboratory take considerable capital and patience, according to Tang.

"Industry-academia collaboration and government support are important to accelerate the transformation of research results," Tang says. It is in light of this that AIE Institute in Huangpu, Guangzhou was launched in May 2020.

Synergizing the innovation chain

With Tang as the founding director, AIE Institute focuses on translational research on AIE, seeking to drive application of AIEgens from health care, environmental protection, public security, to new energy and materials. By building advanced platforms, AIE Institute aims to link scientists with industry to lead the development of emerging technologies in Guangdong-Hong Kong-Macao Greater Bay Area (GBA).

This vision is shared by the local government, which provides ongoing infrastructure, policy, and financial support. To help meet the need for capital for high-tech start-ups, Huangpu District government, for instance, has arranged several online 'match-making' sessions. This has been exemplary for GBA, and the rest of the country.

"Generous government support from Guangzhou Municipal Science and Technology Bureau, Huangpu District as well as South China University of Technology has enabled us to launch the Institute, and overcome complications of time, funding and regulatory hurdles," says Tang. He believes that the incredible potential of GBA, with its growing talent pool and infrastructure, will enable the realization of all the potentials of AIE.

Tang's team has already partnered with industry, including local hospitals, to test the application of their innovations in bioimaging.

"We welcome international talents and enterprises for collaboration across fields to address the challenges of technological innovations," says Tang. ■

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