Light touch from hybrid material heavyweights

Chinese-developed composites are bringing new possibilities to SOLAR INDUSTRIES, FLUORESCENCE-ASSISTED DRUG DELIVERY AND ENVIRONMENTAL SENSING.

Jianguo Tang is the director of the National Center of International Joint Research for Hybrid Materials Technology.

Qingdao University's Institute of Hybrid Materials is pioneering new materials for photonic technologies, including polymer solar cells, luminescent drug delivery and environmental sensors.

"We have pioneered hybrid materials since 2006, particularly nanoscale structures made up of heterogeneous elements linked by non-covalent bonds that create new materials promising higher performance," explains Jianguo Tang, the dean of the institute.

For example, polymers offer the potential for improved environmental outcomes in solar cell production. A nano-structure material formed by lanthanide ion-induced polymer aggregates (LIPAs) has been shown to feature strong photon emission properties. When, in 2018, Tang's team used a LIPA material to enhance the photovoltaic properties in polymer solar cells, they were able to demonstrate a photoelectric conversion enhancement rate of 10.7%, boosting attempts to reach the 18–22% conversion rate of commercial silicon solar cells.

In addition, Tang points out that the biocompatibility of natural biopolymers, such as polysaccharides and proteins, make them good bio-sensor candidates when hybridized with lanthanide emitters that help them luminesce. In a 2021 paper in *Sensors and Actuators B Chemical*, Tang and his colleagues identified natural biopolymer nanoaggregates shaped like dumbbells that can potentially deliver drugs and also sense their level of drug load through changes in fluorescence intensity. This would enable precise tracking of levels of drug delivery and release.

Flexible hybrid polymeric films for solar cells and energy efficient building materials have also been developed at Tang's laboratory. His team make these using functional dopants (such as LIPAs), as well as semiconductor quantum dots and carbon nanotubes. The lab's production line makes 500,000 kg of hybrid polymer films each year.

In a 2020 paper published in the *Journal of Hazardous Materials*, the researchers detailed how LIPAs made of natural polysaccharides enhanced fluorescence performance and biocompatibility in tests designed to detect toxic heavy metals, such as industrial copper, iron and chromium

Qingdao University's institute runs China's Discipline Innovation Programme, the National Center of International Joint Research for Hybrid Materials Technology and The National Base of International Scientific and Technological Cooperation on Hybrid Materials. ■

THE INSTITUTE'S ACHIEVEMENTS SINCE 2016

- **INTERNATIONAL ELITE**
Research is led by Tang with 16 local hybrid materials experts and 16 international scientists from higher education institutions such as Colorado State University (US), Linköping University (Sweden), the Research Institute for Physical Chemical Problems of Belarusian State University and the National Academy of Sciences of Ukraine, including four members of the Foreign Academies of Sciences.

- **RESEARCH PROJECTS**
With over 35 million yuan in funding for hybrid materials research since 2016, the Qingdao research is integrated into China's national development strategy. Two of the institute's projects are from the National Key Technologies R&D Program of China, one is a national major basic research project (Project 973), and more than 20 projects are for the National Natural Science Foundation of China.

- **PUBLISHED PAPERS**
Since 2016, Qingdao University's Institute of Hybrid Materials has published 317 research papers; 209 of these are indexed on the Web of Science Master Journal List.

- **PATENTS**
The institute has submitted 146 Chinese patent applications (44 are approved), and one US and European invention patent each.

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