Indian Journal of Chemistry
Vol. 58B, February 2019, pp. 137-139

Perspective

AIEgens: Rockstars at the age of Adolescence[#†]

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Received 9 July 2018

Flexible or restricted molecular motions (rotation and vibration) play an important role in the existence of molecules in different physical states and as a result equip them with peculiar properties. With the advent of fluorescence technology in biomedical and material sciences, the exploration of new organic molecules has caught great attention. This has led to design and synthesis of novel molecules with intricate properties as required in material and biological applications. The chemical compounds which are able to emit light upon excitation with energy are generally called as luminogens. The fluorescence properties of these molecules may be altered *via* incorporation of donor-acceptor and/or chromophoric functionalities leading to multicolor emission with interesting photophysical and electronic properties. The major drawback with some of the luminogens lies in the fact that their emission quenches upon aggregation due to non-radiative decay processes. This phenomenon is called aggregation caused quenching (ACQ) which was discovered in the year 1954 by Förster[1]. Due to this, the luminescent organic molecules could not be widely used in aqueous biomolecular systems and/or as solid state emissive materials. Since then, a lot of explorations have been carried out keeping this effect in mind and a plethora of publications and discussions kept flowing to cater such challenges. This course of advancement took an entirely new turn when some chromophores on photo-physical examination were found to emit strongly upon aggregation. In 2001, Prof. Tang and co-workers observed this interesting phenomenon and named as aggregation induced emission (AIE) and these molecules were called AIEgens[2]. Further, a mechanistic explanation for this behavior was proposed with the help of the fundamental concept of molecular motion in these molecules. It was later established that it is the restriction of molecular motion (restriction-in-rotation, RIR or restriction-in-vibration, RIV) in these molecules in the solid state or in aqueous/viscous medium which limits the radiative loss of energy and therefore making them highly emissive[3-5]. From this perspective, some fluorophores which remained unknown and unnoticed because of the aggregation caused quenching (ACQ) began to attract the attention of chemists desiring to redesign molecular frameworks by restriction of molecular motions. These molecular systems gained importance as AIEgens.

The restriction in molecular motions either in solid state or in aqueous/viscous medium were observed in different types of organic molecules, particularly those having molecular rotor-based RIR systems like silole, distyrylanthracene (DSA), tetraphenylethene (TPE), tetraphenyl-1,4-butadiene (TPBD), tetraphenyl-pyrazine (TPP), and 2,5-diphenyl-1,4-distyrylbenzene (DPDSB) derivatives[5]. As far as RIV-based AIEgens is concerned, the common examples[6] include 10,10′,11,11′-tetrahydro-5,5′-bidibenzo[*a*,*d*][7]annulenylidene (THBA) and bicyclooctatetraene (BCOT), coumarin derivative CD7, ʌ-shaped pyridinium salt 2,8-(6*H*,12*H*-5,11-methanodibenzo[*b*,*f*]diazocineyl-ene)-di(*p*-ethenyl-N-methyl-pyridinium)ditosylate (DMDPS) and 4-(methylthio)-2-oxo-5,6-dihydro-2*H*-pyrano[3,2-*g*]indolizine-3-carbonitrile (DPI7)[7]. Exemplary, the basic mechanism underlying RIR and RIV-based AIEgens is shown in Figure 1.

Overall these diverse AIEgens not only posses interesting photophysical properties but also offer high resistance to photobleaching thus leading to high photostability and superior signal reliability relative to conventional probes. The multi-facet features and applications of these AIEgens are so rewarding that they may undoubtedly be considered as the "***Rockstars***" in the field of modern science. The intensity with which this phenomenon has spread and caught the attention of researchers can be gauged from the huge number of publications coming out in this area. The statistics of Thomson Reuters in 2015 ranked AIE at #2 in research fronts for chemistry and

[#]Dedicated to Professor Ben Zhong Tang on his 62nd Birthday
[†]CDRI Communication Number 9795

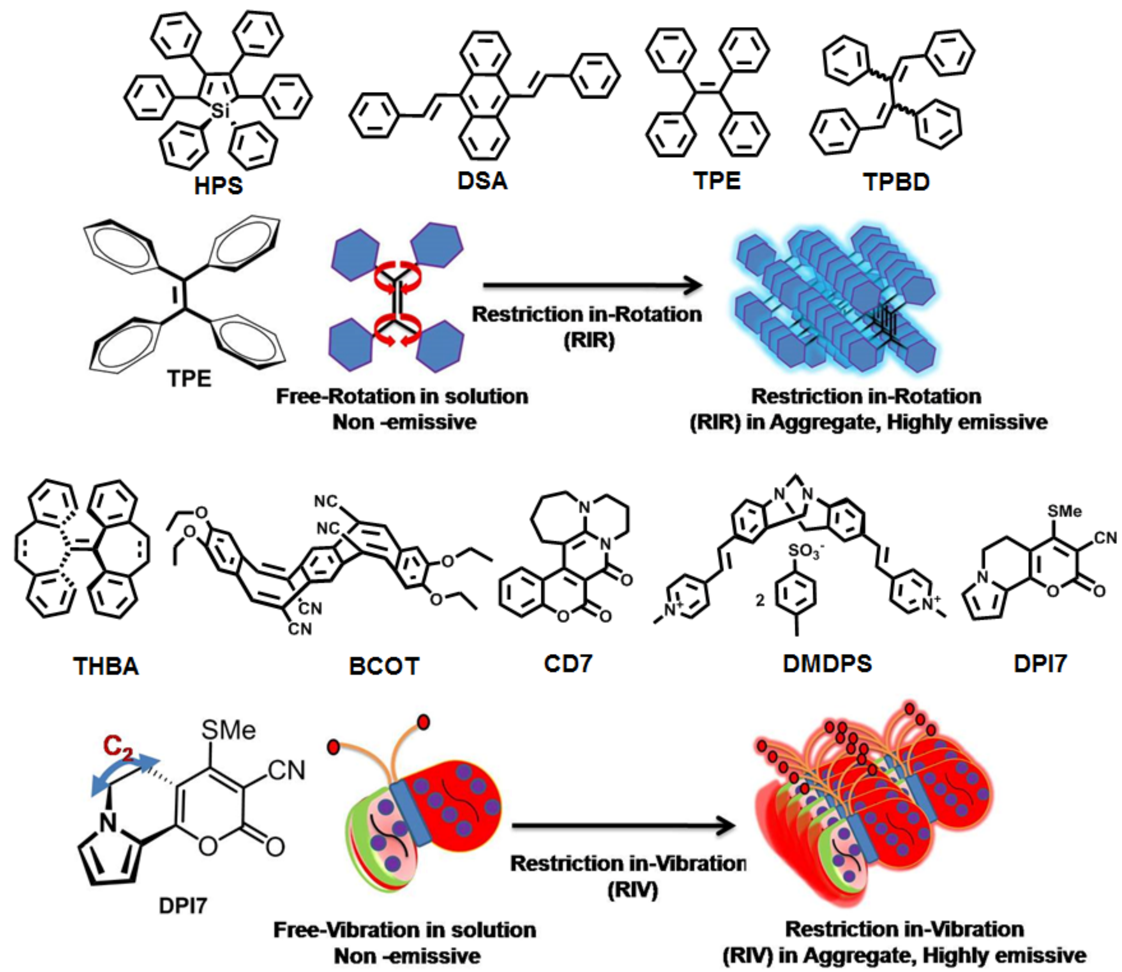

Figure 1 — Typical examples of some common AIEgens operating *via* RIR and RIV mechanism with diagrammatic illustration

materials science. The publications' numbers and citations have been soaring higher and higher with deep impact in different journals and advanced technological fields. The area has attracted a lot of focus and space in many scientific journals that have brought out thematic issues: Journal of Materials Chemistry C: 2016 (Shape-Responsive Fluorophores), Materials Chemistry Frontiers: 2017 (Aggregation-Induced Emission), Faraday Discussion: 2016 (Aggregation-Induced Emission), Molecules: 2017 (Aggregation-Induced Emission: Commemorative Issue in Honor of Professor Ben Zhong Tang's Research Achievements on the Occasion of His 60th Birthday). In addition, several book chapters have also covered the basics, designing strategies, advancement and varied scope of the AIEgens in areas ranging from material, bio-medical imaging, chemical sensor, optoelectronic devices and stimuli-responsive systems to preclinical theranostic approaches.

Even from the time this write-up got its present shape, to the time it would be going through your keen eyes, many new AIEgens would have been synthesized and found application in different areas. Seeing these AIEgens in their youth, at a tender age of eighteen makes us optimistic and gives us a sense of satisfaction. It is hoped that this course of exploration keeps going on at the current high pace, uncovering the various intricacies underlying the material and biochemical systems. Let us all be a part of the journey of exploration of AIEgens, ready to enter into those untouched worlds of research and technology which have a deeper impact on humanity and society as a whole. For a more comprehensive and deeper understanding of the AIEgens, the following recent references may be helpful.

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