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A Simplified Experimental Design to Illustrate an Interesting Application of Electric Field for Enhanced Under-Graduate Learning

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ABSTRACT

Research plays a pivotal role in this rapidly evolving world to create new knowledge and find solutions to various problems of mankind. Laboratory activities enable students to deepen their understanding of the concepts they have learnt and provide them with a rough idea about the research environment. Designing simple and interesting experiments can attract more undergraduate students towards advanced research. Laboratory experiments that demonstrate applying an electric field to produce colour are rare. In this work, we have used affordable and non-toxic material called metal-organic framework (MOF) to show a fascinating phenomenon called electric field-induced self-assembly to create structural colours. The beautiful colour of a butterfly or natural opal stone is due to the interaction of light with well-arranged internal structures, therefore called structural colours. Inspired by these, scientists have developed photonic crystals(PCs), which can artificially produce structural colours. The intriguing property of photonic crystals is the ability to control the propagation of light through them. Hence, it has potential applications in the field of solar cells, anti-counterfeiting, display sensors, etc. MOFs are a new class of materials that can be used to fabricate PCs. They are nanoparticles with inherent surface charges. MOFs like ZIF-8, UiO-66 are dispersed in a solvent such as ethylene glycol, or diethylene glycol and placed between electrodes. In the presence of external voltage, the electric field facilitates the directional movement of MOFs, forming structural colour. This is due to the formation of photonic crystals.Our naked eye can observe a range of colour shifts when voltage is further increased. This experiment can also be used to explain the electrophoretic force. We propose that our experiment can easily demonstrate the phenomenon of electric field-induced self-assembly and the interesting properties of PCs, hence cultivating scientific inquisitiveness among young minds.

KEY WORDS

Laboratory experiments, electric field-induced self-assembly, undergraduate students, metal-organic frameworks, structural colour, photonic crystals

BIOGRAPHY

#Biography: *Mrs. Juveena Piyus is pursuing PhD degree in Chemical Engineering from RMIT University under the supervision of Dr. Jue Hou and Assoc. Prof. Huacheng Zhang. Currently, her research interest includes investigating the orientated assembly of MOF nanocrystals and the fabrication of better colourimetric sensors specifically used in intelligent packaging for food freshness, environment monitoring, and pollution detections by employing photonic crystals constructed using metal-organic frameworks.*

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