INFLUENCE OF PMMA AND PEG ON ORGANIC PEROVSKITE $MAPbI_3$ QUANTUM DOTS COMBINED WITHIN POLYMER MATRIX

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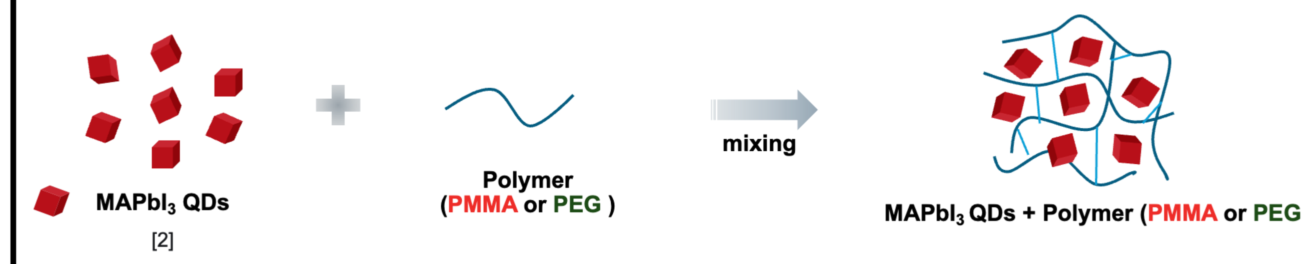
ABSTRACT

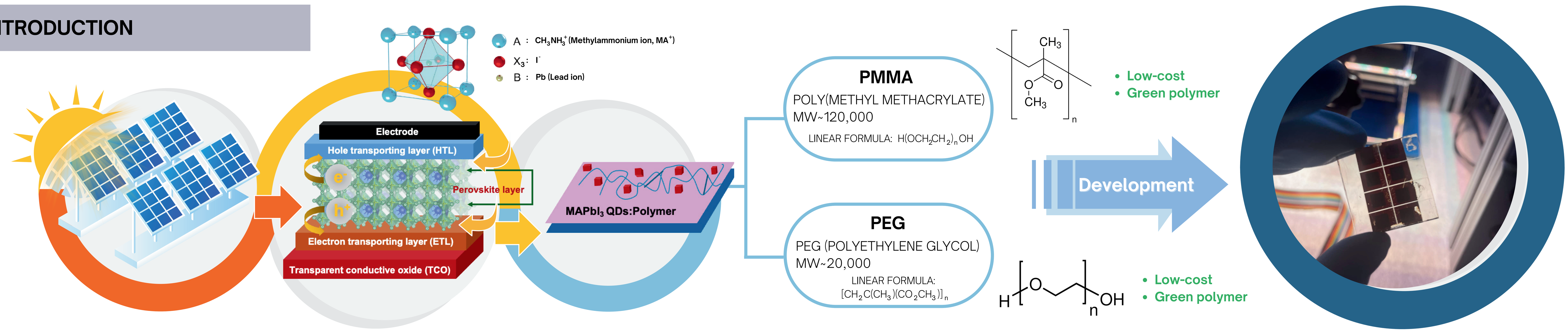
This research examines the effects of PMMA and PEG on the stability and optical properties of $MAPbI_3$ QDs perovskite quantum dots, which degrade under high humidity. These polymers enhance stability by shielding the quantum dots from environmental factors. Experiments were conducted at room temperature (55-60% RH) to assess the impact of PEG and varying PMMA proportions. The $MAPbI_3$ QDs:PMMA (1:1) mixture showed superior photoluminescence stability without altering absorption, outperforming pure $MAPbI_3$ QDs, which degraded within 12 minutes under 365 nm UV light. $MAPbI_3$ QDs:PMMA also exhibited better compatibility than $MAPbI_3$ QDs:PEG. This study contributes to developing more stable perovskite layers for solar cells.

OBJECTIVE



To study the effect of PMMA and PEG polymers combined with $MAPbI_3$QDs.

INTRODUCTION



Advancements in perovskite solar cell (PSC) technology , particularly with $MAPbI_3$ perovskite quantum dots ($MAPbI_3$QDs), have revolutionized the field of renewable energy due to their high optical efficiency and potential for various applications. However challenges like long-term stability and environmental concerns lead-based materials remain critical . To address these challenges, recent research has focused on incorporating polymethyl methacrylate (PMMA) and polymers polyethylene glycol (PEG) as stabilizers for $MAPbI_3$QDs. While PEG offers water-soluble polymer and flexibility, PMMA excels due to its strength light resistance, and durability. PMMA not only acts as a protective layer, shielding $MAPbI_3$ QDs from environment degradation under humidity and room temperature conditions , but also enhances light absorption, quantum dots dispersion, and long-term material stability, making it a pivotal component in driving practical advancement in PSC technology.

METHODOLOGY

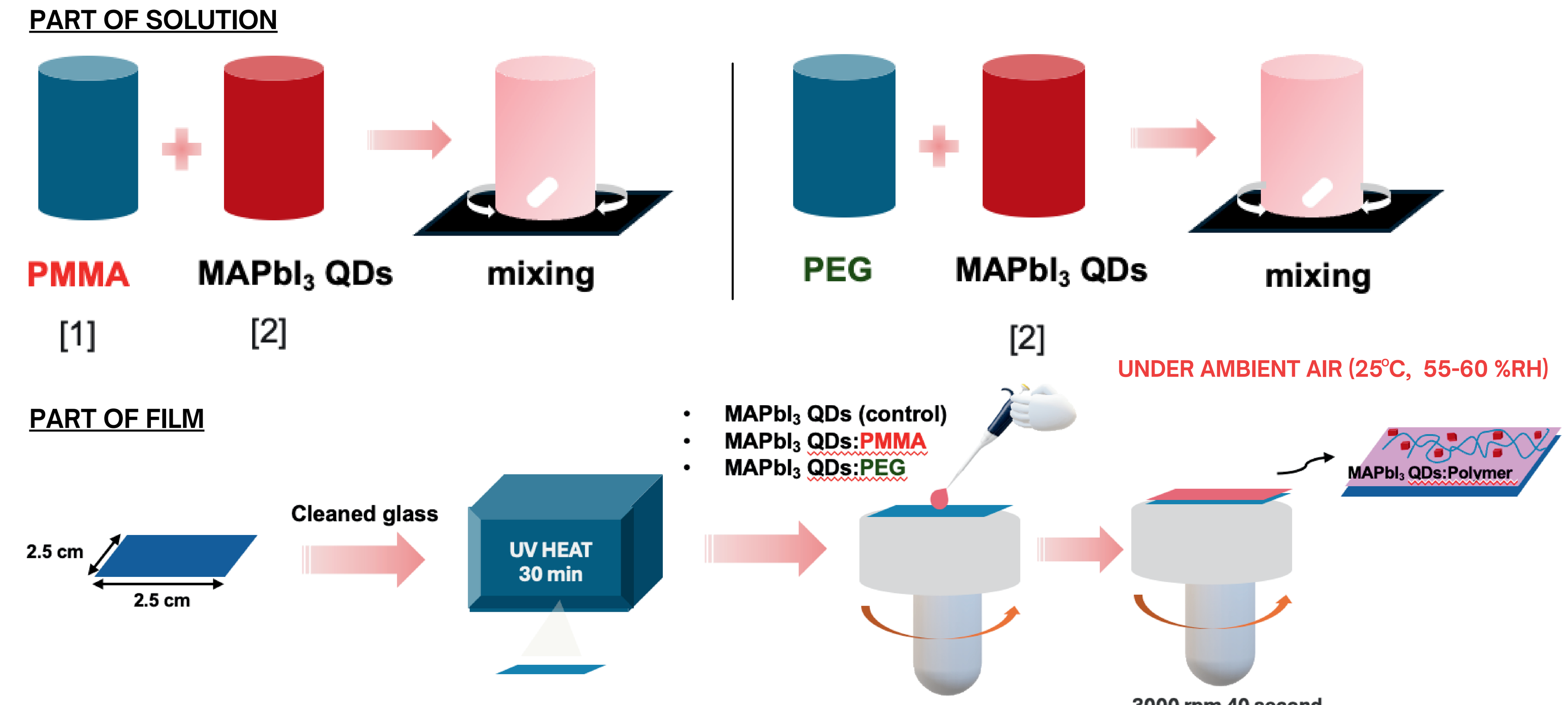


Fig 1 Schematic diagram of the solution preparation and film coating process.

RESULTS AND DISCUSSION

CONTACT ANGLE CHARACTERIZATION

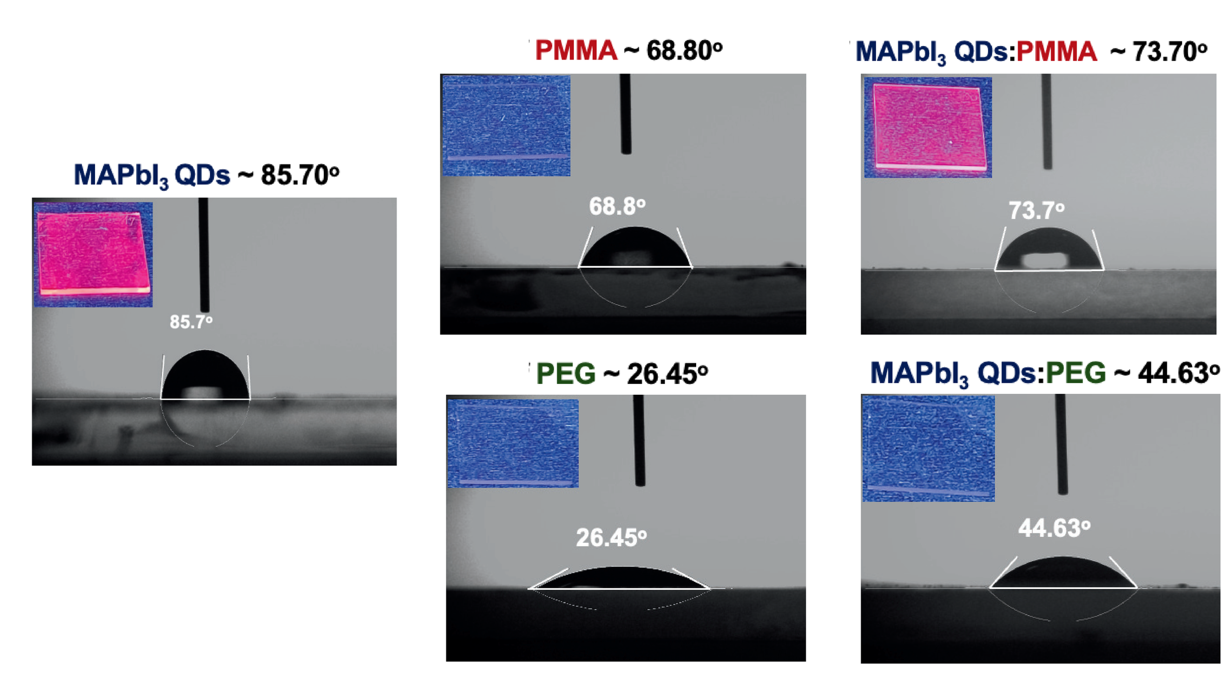


Fig 2 The results of the film from contact angle measurement.

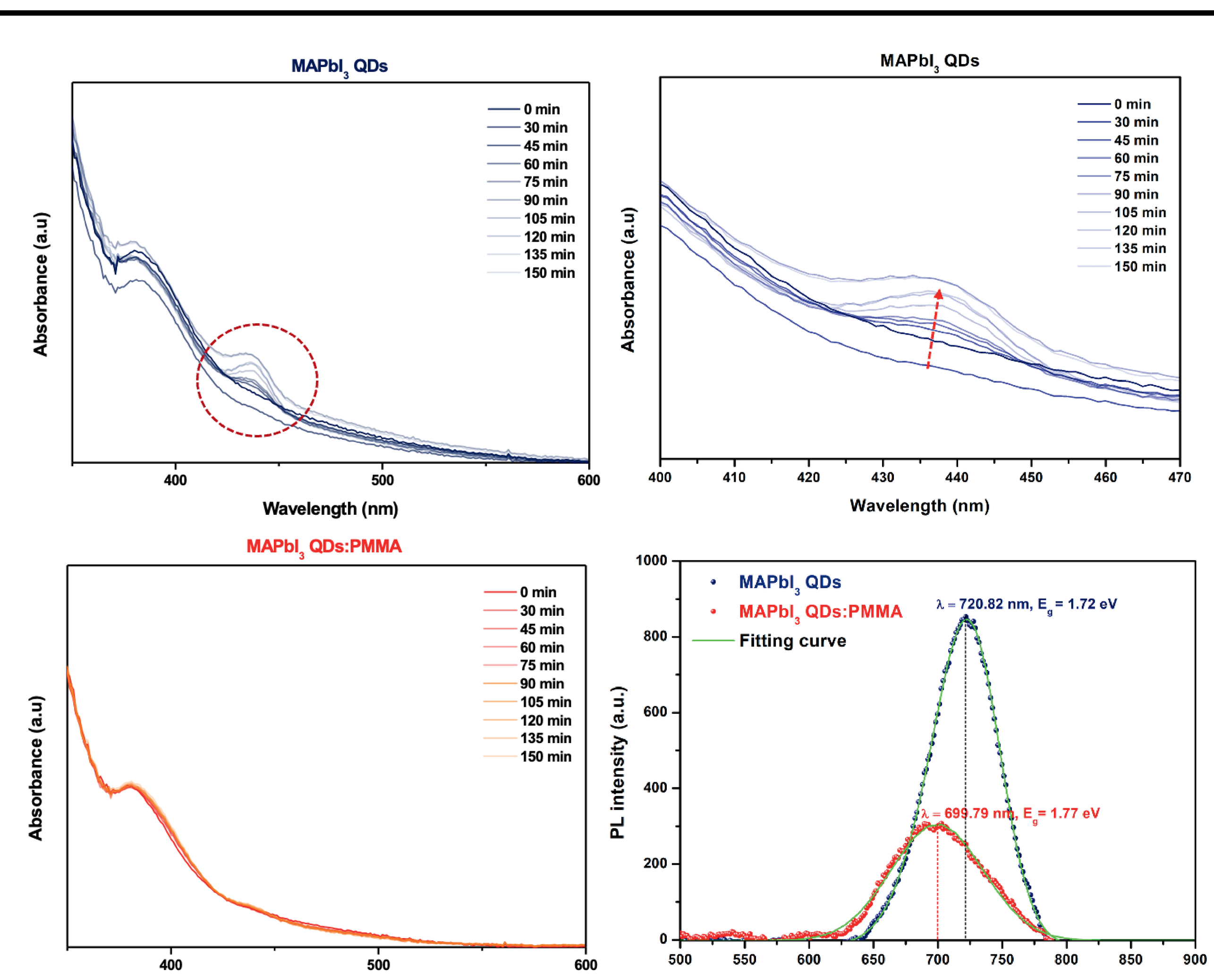


Fig 3 Test results on shelf-stability using UV-Vis absorbance and photoluminescence (PL) spectroscopy.

- **Stability test** : $MAPbI_3$ QDs:PMMA (1:1) showed enhanced stability (150 min) under 25°C and 50-60 %RH $MAPbI_3$QDs (45 min).
- **Degradation causes** ($MAPbI_3$QDs) : Material breakdown, moisture, light-induced degradation, phase separation, and surface structural changes.

- **Rule of PMMA**
  - acts as a protective layer, shielding $MAPbI_3$QDs from environmental factors.
  - improves QDs dispersion and light absorption
  - contributes to long-term stability without compromising optical performance.
  - maintains light absorption and enhances material performance.

THE RESULTS OF THE FILM

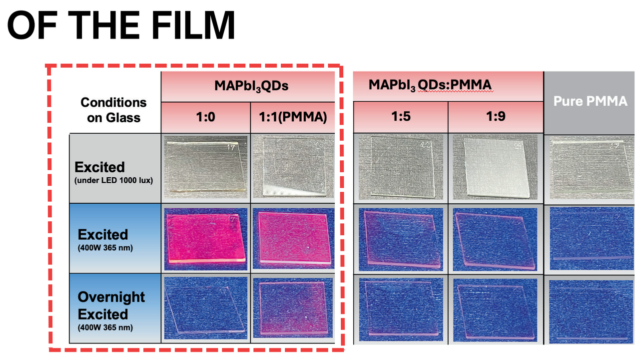


Fig 4 Test Results of film $MAPbI_3$QDs and $MAPbI_3$QDs:PMMA at ratios of 1:1, 1:5, and 1:9 under different conditions.

RESULTS AND DISCUSSION

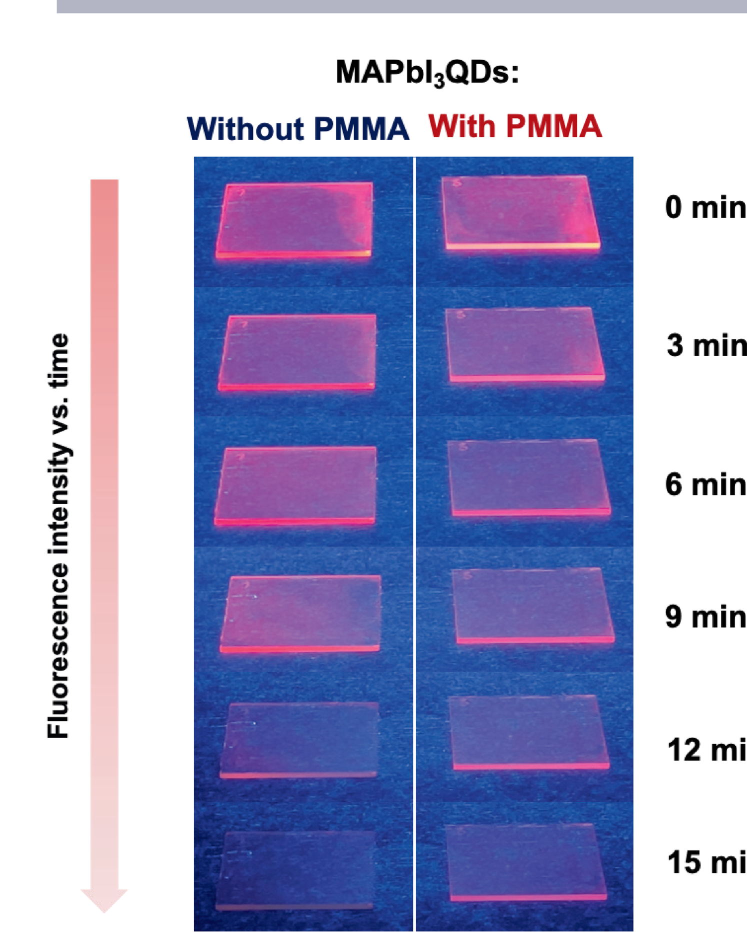


Fig 5 UV (365 nm) with 400 W stability of the films at different time.

CONCLUSIONS

This study focuses on improving the stability and luminescence efficiency of $MAPbI_3$QDs by using PMMA and PEG. The results showed that $MAPbI_3$ QDs:PMMA (1:1) exhibited better compatibility and stability compared to PEG. UV-Vis and PL analyses confirmed that PMMA helped reduce aggregation of the quantum dots, increased the energy gap (Eg), and protected against moisture and oxygen. Additionally, UV stability testing under ambient air conditions revealed that $MAPbI_3$QDs with PMMA demonstrated higher stability than those without PMMA. Luminescence experiments showed that the emission began to decrease within 12 min and completely faded after 15 min. Therefore, PMMA is an effective polymer for enhancing the stability of $MAPbI_3$QDs without affecting their light absorption range.

ACKNOWLEDGEMENTS

This research was financially supported by the Solar Cell Research Laboratory (SCRL), Department of Physics and Materials Science, Faculty of Science, Chiang Mai University. The authors would like to express their sincere gratitude to Ms. Woraprom Passatorntaschakorn, Ms. Warunee Khampa and Mr. Pattanasak Tipparak for their invaluable support and guidance, which have been instrumental in the success of this study.

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