MEET4-1
Invited

Quantum Dots and Perovskites for Display, Lighting and Photomedicine

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ABSTRACT

Luminescent nanomaterials, including quantum dots and metal halide perovskite nanocrystals, have emerged as key building blocks for various photonics and optoelectronics applications. In this talk, I will present our recent work on photoluminescent perovskite materials and electroluminescent quantum dot devices, with focus on their potential applications for novel display, lighting and photomedicine (photodynamic therapy and photobiomodulation).

1 INTRODUCTION

In 2016, a versatile swelling-deswelling microencapsulation strategy was developed by the authors' team to achieve well dispersed, intimately passivated, green emitting perovskite nanoparticles inside polymer matrixes and led to perovskite-polymer composite films with high photoluminescence efficiency, color purity and ultrahigh stability against heat and water exposure [1].

Ever since then, we have further improved this strategy through ligand assistance and processing optimization (Figure 1) [2,3]. The optimized SDM-based perovskite polymer composites have found potential applications in LCD back light, transparent projection display, anticounterfeiting and X-ray scintillation based medical imaging.

While electroluminescent quantum dot (ELQD, also known as QLEDs) was mainly touted as an ultimate display technology in the long term, the relatively short lifetime of QLEDs and the limited development of blue devices have been formidable challenges for their entry into the display market. My group has been exploring QLEDs for high value-added photomedical light source markets in the near term [4]. Widespread clinical adoption of photodynamic therapy (PDT) and photobiomodulation (PBM) has been limited due to the lack of a suitable commercial light source.

QLED devices promise to be an ideal light source nicely fitting into this niche, not only complying with desired form factors - flexibility, lightweight, and uniform large area illumination – but with narrow emission spectrum and high power density at clinically relevant deep red wavelengths.

2 EXPERIMENT

We envisioned QLED-based photomedical light sources will present unique opportunities for three research fields, i.e. flexible OLED lighting, ELQD and photomedicine (Figure 2).

OLED communities have developed relatively mature technologies for making solid state lighting products with unique form factors as thin, flexible, light weight and uniformly large area luminaire, but they remain struggling in finding the right, cost insensitive lighting application that can fully take advantage of these features.

3 RESULTS AND DISCUSSION

As a result, most OLED lighting manufacturing facilities have been idle. Their established knowledge in flexible substrate, thin film encapsulation, barrier films and adhesives will be important to enable development of flexible QLEDs which, as an emerging technology, have clear advantages in for photomedicine.

The joint efforts of OLED and QLED communities will enable thin, flexible, light weight, homogeneously large area QLED devices that will gear up the adoption of photomedicine in multiple hundred billion dollar healthcare markets, helping manage cancer, acute and chronic wounds, inflammation, and antimicrobial resistance among others.

4 CONCLUSIONS

We propose in Figure 3 a set of basic requisites for near future application of flexible QLEDs in PDT and PBM. As depicted, a suitable and effective QLED should

be a disposable and bendable light source with operating lifetime ≥ 6 h (average in air), shelf-life ≥ 1 month and minimum bending radius ~6.5-10 mm. Simultaneously, the figure excludes some features such as transferability, transparency, stretchability and foldability, which could be usable but are not restrictive for external treatment of the body's skin and/or oral cavity. The rationale of these requisites and how QLEDs can meet them will be briefly discussed.

In addition, I will report our recent progress on flexible QLED device development and related in-vitro medical studies which promise to enable the widespread clinical acceptance of photomedical strategies for cancer treatments, wound repair or aesthetics in the near future.

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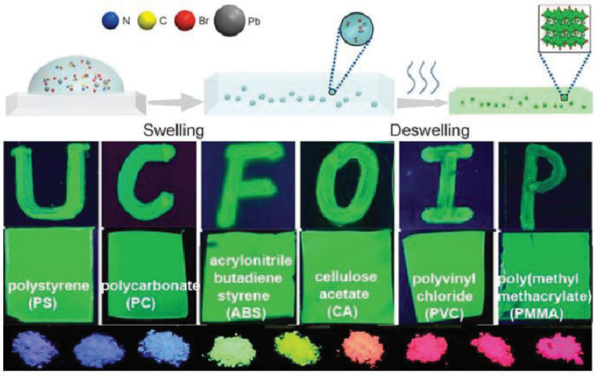

Fig. 1 Swelling-Deswelling Microencapsulation-Enabled Ultrastable Perovskite-Polymer Composites.

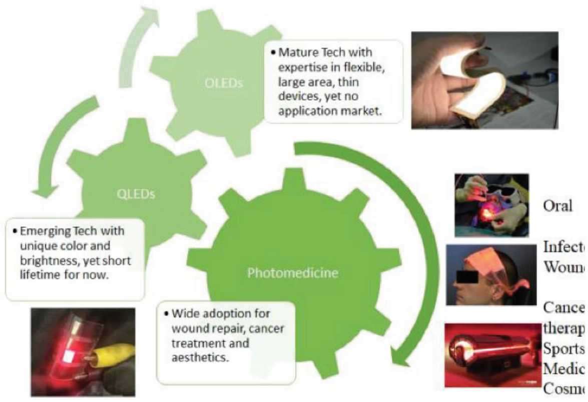

Fig. 2 QLED Photomedicines represents unique opportunities for OLED lighting, QLED and photomedicine.

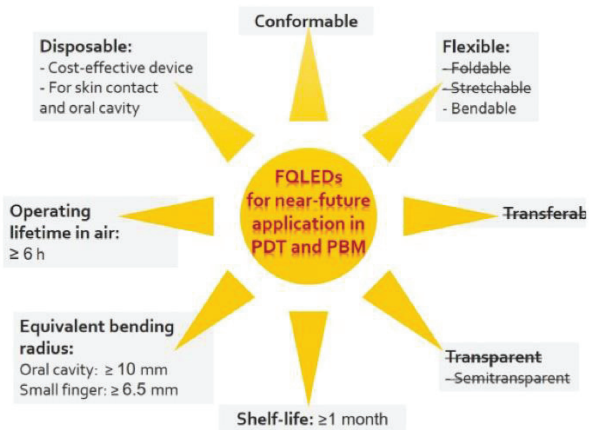

Fig. 3 Perspective on near future introduction of QLEDs in the photomedicine market.