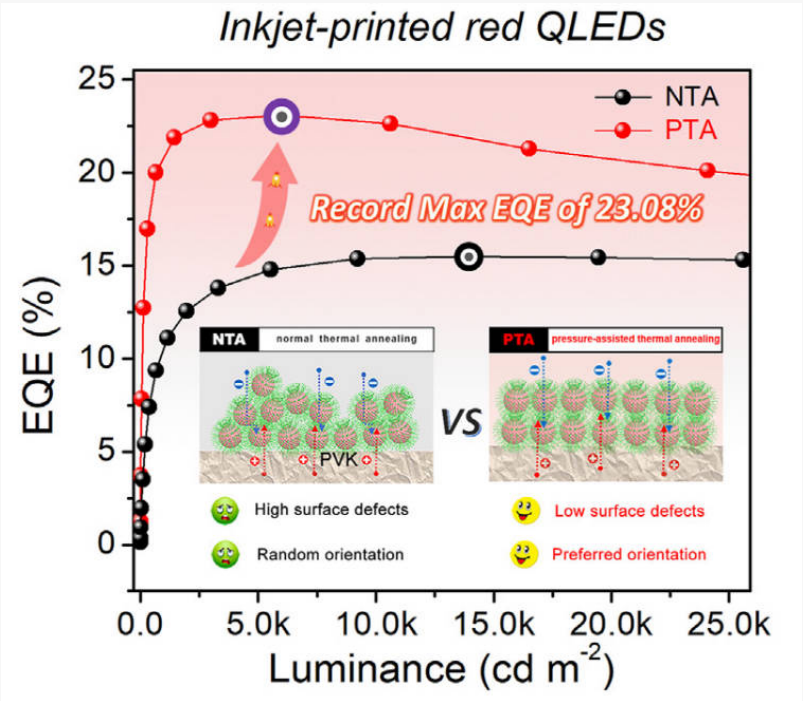
Game-changer for TV screens: new inkjet-printed QLEDs break efficiency records

GA, UNITED STATES, February 7, 2025 /EINPresswire.com/ -- Researchers have achieved a monumental leap in the efficiency and stability of inkjet-printed quantum-dot light-emitting diodes (QLEDs) by employing a pressure-assisted thermal annealing (PTA) technique, which enables the acquisition of highly ordered quantum-dot (QD) thin films via inkjet printing. This innovative approach has propelled QLEDs to unprecedented external quantum efficiency (EQE) over 23%, signaling a significant step toward the mainstream adoption of this display technology.



Record-Breaking Efficiency of Inkjet-Printed QLEDs Enabled by PTA Processing.

Quantum dot light-emitting diodes (QLEDs) have emerged as a cornerstone of next-generation display technology, renowned for their unmatched color purity and stability. Despite this promise, the traditional spin-coating methods commonly employed in QLED fabrication restrict scalability and drive-up costs, impeding their widespread adoption. While inkjet printing offers a scalable and cost-effective alternative, it faces obstacles such as suboptimal film uniformity and reduced device performance. To overcome these challenges and unleash the full potential of inkjet-printed QLEDs, a more profound investigation into post-processing techniques was imperative.

A collaborative research team from Nanjing University of Science and Technology, in along with international partners, has pioneered a novel pressure-assisted thermal annealing (PTA) strategy to transform inkjet-printed QLEDs. Published (DOI: 10.1016/j.esci.2023.100227) in eScience on December 29, 2023, the study highlights how PTA enables the creation of highly ordered quantum dot films, establishing new performance benchmarks. Remarkably, red QLEDs achieved a record-breaking EQE of 23.08%, marking a significant milestone in QLED innovation.

The researchers unveiled a transformative PTA process that redefines the quality of inkjet-printed QD films. Through meticulous control of solvent evaporation within a vacuum-assisted environment, the PTA technique produced films characterized by smoother surfaces and enhanced QD alignment. This innovative process yielded unparalleled film uniformity, with a root-mean-square roughness of a mere 0.54 nm, far surpassing conventional annealing methods.

The refined morphology of PTA-treated films dramatically bolstered charge transport and minimized defects, leading to extraordinary device performance. The red QLEDs realized a remarkable EQE of 23.08%, along with an operational lifetime that exceeded 343,342 hours at a brightness of 100 cd/m². Green QLEDs similarly showcased an impressive EQE of 22.43% and an operational lifetime that surpassed 1,500,463 hours. Additionally, the PTA approach has proven its scalability, maintaining uniformity across large-scale films. This breakthrough sets the stage for high-performance, cost-effective manufacturing of next-generation QLEDs.

“This breakthrough demonstrates the transformative potential of the PTA strategy in surmounting the challenges associated with inkjet-printed QLEDs," stated Prof. Dr. Haibo Zeng, the study's lead researcher. " Attaining such remarkable efficiency and stability underscores the precision and scalability inherent in our approach, heralding a new era for display technology."

The PTA process presents a scalable and cost-effective manufacturing solution for high-performance QLEDs, with applications that reach beyond the realm of displays to encompass lighting and optoelectronics. By lowering production costs and significantly enhancing device longevity, this innovation accelerates the transition of QLEDs from research to market, promising profound impacts on the consumer electronics and lighting industries.

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