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# Contact free micro-scale pick and place

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## ABSTRACT

Micro light-emitting diodes (μLEDs) offer exceptional electrical, optical, and mechanical properties, making them ideal for flexible and high-performance display applications. However, their widespread commercialization is hindered by high manufacturing costs and process inefficiencies. To overcome these challenges, advanced micro-transfer printing techniques are crucial for the precise and scalable assembly of μLEDs. Near-field acoustic levitation (NFAL) has emerged as a promising contact-free pick-and-place approach, generating attractive forces when object dimensions are small relative to the acoustic wavelength. While NFAL has been extensively studied at the millimeter and meter scales, its applicability at the micro/nanoscale remains unclear, and existing macroscopic prediction models may not fully capture its behavior in this regime. In this study, we establish computational models to investigate acoustic levitation effects at the microscale, laying the foundation for its potential integration into μLED transfer printing. Additionally, we introduce an atomic force microscopy (AFM)-assisted acoustic force measurement technique to validate the computational model and analyze key vibration parameters, enabling precise control of acoustic forces for micro-object manipulation.