Towards Electrically Pumped Organic Lasers

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Electrically pumped organic lasers (OPLs) remain a major challenge in organic optoelectronics despite substantial advances in high-current-density devices and dual-device architectures. Our work demonstrates significant progress in light-emitting transistors, bringing their efficiencies, luminance, current densities, and temporal response to record-new levels[1,2]. Furthermore, we recently demonstrated polymer micro-OLEDs operating at room-temperature current densities approaching 1.5 kA cm^{-2} and revealed the fundamental excitonic processes preventing lasing. Spatio-temporal experiments and device simulations identify singlet–triplet annihilation, polaron-induced quenching and, critically, excited-triplet photon absorption as major loss mechanisms[3]. Building on this understanding, multi-resonant thermally activated delayed fluorescence (MR-TADF) materials provide a promising route toward lower lasing thresholds through reverse intersystem crossing and efficient harvesting of electrically generated triplet excitons[4]. Engineering exciton populations, charge transport, optical gain and cavity losses therefore provides a rational pathway toward overcoming the electrical-pumping barrier and realising practical organic semiconductor laser diodes.

References.

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