# Machine Learning-Assisted Smart Epitaxy of III-V Quantum Dot and Devices

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Self-assembled InAs/GaAs quantum dots (QDs) possess valuable properties for developing various optoelectronic devices, including QD lasers and single-photon sources. The effectiveness of these applications largely depends on the density and quality of the quantum dots. This dependence has led to increased research on controlling the growth process to achieve high-quality epitaxial wafers and devices. Traditionally, optimizing material growth using molecular beam epitaxy (MBE) involves a time-consuming trial-and-error approach. Here, we realize the growth of QDs with arbitrary density by a real-time feedback control method, which is fully automated and intelligent. We develop an ML model named 3D ResNet 50 trained using RHEED videos as input and providing real-time feedback on surface morphologies for process control. As a result, we demonstrate that ML from previous growth could predict the post-growth density of QDs by successfully tuning the QD densities in near-real time from 3.8×10^8 cm^{-2} to 1.4×10^{11} cm^{-2}. This fine-tuned control over the growth process results in lasers operating at 1240 nm with performance comparable to those of traditional lasers.
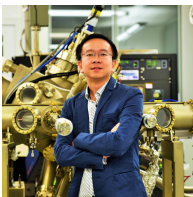
Short Bio:

Professor Zhao Chao works on large mismatch heteroepitaxial semiconductors, focusing on the physical mechanism of mismatch and the construction of optical chips. He has published more than 130 research papers, with a total citation of 5300 and an H-index of 32. He has been authorized 6 US patents and 4 Chinese patent. He is undertaking national key research and development plan projects, NSFC projects, and high-level talent plans of CAS. He served as associate editor of IEEE PTL and Electronics Express, received the "High-Level Talent Program" of the Chinese Academy of Sciences " (2020); elected as a fellow of the Institute of Physics (IOP) (2022).