Unveiling the Growth Dynamics of $CsPbBr_3$ Microcrystals with Various Geometries via Single-step CVD Process

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Uncovering the intricate growth mechanism for precise shapes and crystalline quality control during the chemical vapor deposition (CVD) process remains challenging due to the complex nature of potential reactions. Our study elucidates a systematic novel approach to investigate the selective and simultaneous growth of $CsPbBr_3$ perovskite crystals with varied morphologies including microrods (MRs), microplates (MPs), and microspheres (MSs) using a temperature gradient single-step CVD system. By strategically adjusting the precursors evaporation temperature, optimizing nucleation conditions, and analyzing carrier gas flow dynamics, we surpass previous techniques [1,2,3] via achieving a precise control over the growth of each morphology separately. Thanks to the turbulence flow of the carrier gas around the crucible, the $PbBr_2$ concentration manipulated across distinct regions (varied temperature and substrate distance) of the vertically placed mica substrate resulting in diverse morphological growth. Additionally, the vertical discrete positioning and orientation-dependent study confirm the direct influence of temperature and carrier gas turbulence on the distinct morphological growth over the selected territory (top, middle and bottom) observed on both faces of the mica substrate. Structural analysis conducted via X-ray diffraction (XRD) and high-angle annular dark-field scanning transmission electron microscopy (HAADF-STEM) reveals the well-aligned atomic order without dislocation/defect ensures a single crystalline orthorhombic phase structure of as grown geometries. Moreover, the epitaxial growth of $CsPbBr_3$ morphologies, particularly MRs, facilitated by lower lattice mismatch of mica substrate offering a foundation for the development of tailored perovskite materials for diverse optoelectronic applications. [4,5] Finally, we investigated the polaritonic and photonic lasing behavior in the as grown MRs and MPs to demonstrate its ability for future optoelectronic applications.

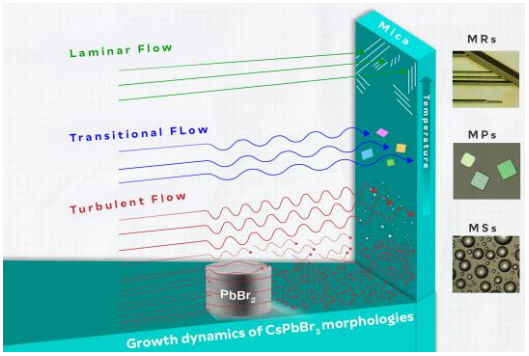

Fig.1. Impact of fluid flow (carrier gas) on selective and simultaneous growth morphologies.

References

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