Contribution ID: **31** Type: **Poster Presentation**

Optimization of 2D perovskite thin films for photodetectors

Thursday, 20 July 2023 17:10 (20 minutes)

2D perovskite thin films have attracted significant attention for their potential use as high-performance detectors due to their unique optical and electronic properties. These materials crystallize in a natural self-assembled quantum well-like structure and possess several interesting features, including synthesis at relatively low temperatures (below 100℃) and low defect density.1 Furthermore, 2D perovskites have shown good stability in various environments, such as ambient conditions, humidity, and temperature, making them suitable for use in everyday applications. In photodetection, 2D perovskites have been used to create high-performance photodetectors with low dark current, high responsivity, and fast response time.2 The ability to deposit 2D perovskites using low-cost solution processing techniques, such as spin-coating and spray-coating, also makes them attractive for large-scale fabrication.
However, one of the main challenges in developing high-performance detectors is the deposition of high-quality thin films. The morphology and crystalline quality of the thin films can significantly affect their optical and electronic properties, which in turn can affect their sensitivity, response time, and stability.3 Therefore, the deposition conditions must be carefully controlled to ensure the formation of uniform and defect-free thin films.

In this study, we present the optimization of 2D perovskite thin films for photodetectors using chemical deposition in an inert nitrogen atmosphere. We focused on the hybrid perovskite PEA2PbBr4 (PEA = C6H5C2H4NH3+), deposited using the spin-coating method. The optimization of these thin films was achieved by changing the deposition speed, solvent for the perovskite solution, use of plasma cleaning before the deposition, addition of an anti-solvent during deposition, and changing the number of deposited layers. The deposition was carried out on Kapton samples on a glass substrate, at 800, 2000, and 6000 rpm. DMF and DMSO were used as solvents for preparing the perovskite solution. Samples were made with one and two layers of perovskite thin film. Additionally, we explored the impact of adding chlorobenzene as an anti-solvent. Before deposition, samples were treated with oxygen plasma. Our results showed that the best performance was achieved using a deposition speed of 2000 rpm with the addition of an anti-solvent. Moreover, the perovskite solution with DMF as a solvent showed better results in terms of adhesion of microcrystals to Kapton compared to the perovskite solution with DMSO. Our findings demonstrate the importance of optimizing the deposition process for 2D perovskite thin films to achieve better photodetector performance. Further research is needed to develop large-area films with even better uniformity which could be integrated into existing and new technologies for practical applications.

1. Lédée, Ferdinand, et al Advanced Optical Materials 10.1 (2022): 2101145.
2. Chu, Kai-Lin, et al. Chemical Engineering Journal 422 (2021): 130112.
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Presenter: CEPIĆ, Sara

Session Classification: Session 4 (Posters)

Track Classification: default track