A novel optical approach to high-resolution thickness and roughness analysis of two-dimensional metal-organic frameworks

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Abstract

Two-dimensional (2D) metal-organic frameworks (MOFs), a novel type of crystalline porous 2D material-system, composed of metal nodes and organic ligands show great potential for technology areas such as (opto-)electronics and sensors, benefiting from their tailorable structures, functionalities, and electrical properties [1]. Towards system-integration of 2D MOFs, one of critical tasks is to find a practical strategy for fast and routine characterization of film thicknesses and quality obtained by liquid-based layer-by-layer epitaxy from MOF precursors.

In present work, we developed a novel optical analysis model for MOF thin films, including thickness and surface roughness, which can be accomplished by the most accessible optical microscopes (e.g. Nikon) and be compatible with current technologies. To do so, Fresnel's law and a tri-layer model were applied [2], in which thin-film thicknesses were obtained from AFM measurements, and then optical constants (e.g. refractive index) were modelled from multi-sample ellipsometry measurements. Prior to all the characterizations, MOF thin films were fabricated on SiO_2/Si wafers via layer-by-layer liquid-phase epitaxial growth [3], and patterned by lithography technologies. As a result, the theoretical values are comparable with experimental results. Furthermore, this optical model was applied to characterize thin-film thicknesses and surface roughness, and do 3D projection. Eventually, a graphical user interface was programmed (**Figure 1**). As an outlook, the optical model is of great potential for bio-/chemical sensing due to the change of refractive indices of MOFs and corresponding contrast.

References

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Figures

Figure 1: (a) Graphical user interface based on the developed analytical model for MOF thin films, inset shows thickness and surface roughness. (b) Brightness deviation of the selected region. (c) 3D projection for the selected region.