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Nucleation and Growth Kinetics in Solution-Processed Organic Molecular Crystalline Thin Films.[1] DAVID PATRICK, BRAD JOHNSON, CYRUS SCHAAF, MICHAEL JENKINS, LINNEA BAVIK, Western Washington University, WESTERN WASHINGTON UNIVERSITY TEAM — We report in-situ, real-time observation of early stage nucleation and growth kinetics in submonolayer crystalline films of the organic semiconductor tetracene grown in ultrathin liquid solvent layers. Films are prepared using a vapor-liquid-solid deposition technique in which tetracene monomers are delivered at a constant rate via a vapor-phase flux to a substrate coated with a sub-micron thick layer of an organic liquid solvent, causing crystals to nucleate and grow. Using fluorescence videomicroscopy we follow the formation and growth of individual crystals, including simultaneous mapping of spatial variations in monomer concentration and depletion zones. A unified theoretical treatment accurately describing the time- and flux-dependent nucleation rate, limiting nucleation density, steady-state growth rates, and crystal spacing statistics is developed by modifying the Walton relation to account for the presence of the liquid solvent, with the critical nucleus size treated as a concentration-dependent variable. We discuss the differences between molecular crystallization in quasi-2D liquid films, versus traditional growth on a bare substrate in vacuum by physical vapor deposition (PVD).

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