Layer-by-Layer, J-aggregate Thin Films with an Absorption Constant of $10^6$ cm$^{-1}$ in Optoelectronic Applications

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Sponsorship: DARPA Optocenter, NDSEG, NSF-MRSEC

Thin films of J-aggregate cyanine dyes deposited by layer-by-layer (LBL) assembly exhibit exciton-polariton dynamics when incorporated in an optical microcavity. Such LBL, J-aggregate thin films can be precisely deposited in a specific location in an optical microcavity, enabling the development of previously unachievable optoelectronic devices, as for example, the recently demonstrated resonant-cavity exciton-polariton organic light-emitting device [1].

To gain insight into the physical properties of these films, we investigate the optical and morphological properties of 5,6-dichloro-2-[3-[5,6-dichloro-1-ethyl-3-(3-sulfopropyl)-2(3H)-benzimidazolidene]-1-propenyl]-1-ethyl-3-(3-sulfopropyl) benzimidazolium hydroxide, inner salt, sodium salt (TDBC) J-aggregates, alternately adsorbed with poly(diallyldimethylammonium chloride) (PDAC) on glass substrates. Atomic force microscopy (AFM) shows that the first few sequential immersions in cationic and anionic solutions (SICAS) form layered structures, which give way to Stransky-Krastanov-type growth in subsequent SICAS. We combine thickness measurements from AFM and spectroscopic data to determine the optical constants of the films and find that at the peak absorption wavelength of 596 nm, the films possess an absorption coefficient of $\alpha = 1.05 \pm 0.1 \times 10^6$ cm$^{-1}$, among the highest ever measured for a neat thin film. The optical constants were calculated by fitting spectroscopic data for films in the layered growth regime to a model based on propagation and matching matrices (Figure 1).

The presented method is a general approach to generating thin films with very large absorption constant, an enabling step in the fabrication of novel devices that utilize strong coupling of light and matter, such as light emitting devices (Figure 2) and polariton lasers.

**REFERENCES:**