Type of presentation: Invited

IT-10-IN-3013 Functional soft matter

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The design and synthesis of materials with novel functional properties is a major focus of chemical research. This includes soft matter which are formed by the interactions that arise from (self)-organizing molecules, polymers, and clusters over length scales beyond typical small molecule dimensions. To understand and apply the processes that underlie the formation of nanoparticles and their self-organization into larger functional structures requires 3D nanoscale imaging [1,2]. We focus on the (liquid phase) (self)-organization of soft (in)organic materials and composites thereof using cryogenic (scanning) TEM electron tomography (ET). In this presentation I will take you through the complex and beautiful 3D nano and meso landscape of functional soft matter. Examples will include quantitative ET of a Ruthenium loaded carbon nanotube based heterogeneous catalyst (Figure 1a) [3], quantitative ET of the assembly process of organic solar cell bulk heterojunctions composed of P3HT and PCBM polymers (Figure 1b) [4], and cryogenic ET of liquid infiltration and drying processes in ordered mesoprorous silica (SBA-15) crystallites [5]. Since to-date, more frequently a detailed quantification understanding of particle sizes, size distributions, or particle location and distances is required, I will focus on this information contributes to determine the self-organization pathways [6,7]. Furthermore, I will discuss the effects of limited electron dose, applied angular sampling scheme, and reconstruction algorithm on the achievable 3D resolution (Figure 1d-h) [8,9]. Our findings suggest that for cryo conditions fewer images in the tilt-series are advantageous, contradictory to Crowther's sampling-based resolution estimate [8,9]. Finally, I will conclude with an outlook on trends for 3D imaging.

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[5] T. M. Eggenhuisen et al, Chemistry of Materials 25 (2013) 890.

[6] G. Prieto et al, Nature Materials 12 (2013) 34.

[7] J. Zečević et al. ACS Nano 7 (2013) 3698.

[8] D. Chen et al. Journal of Physical Chemistry C 118 (2014) 1248.

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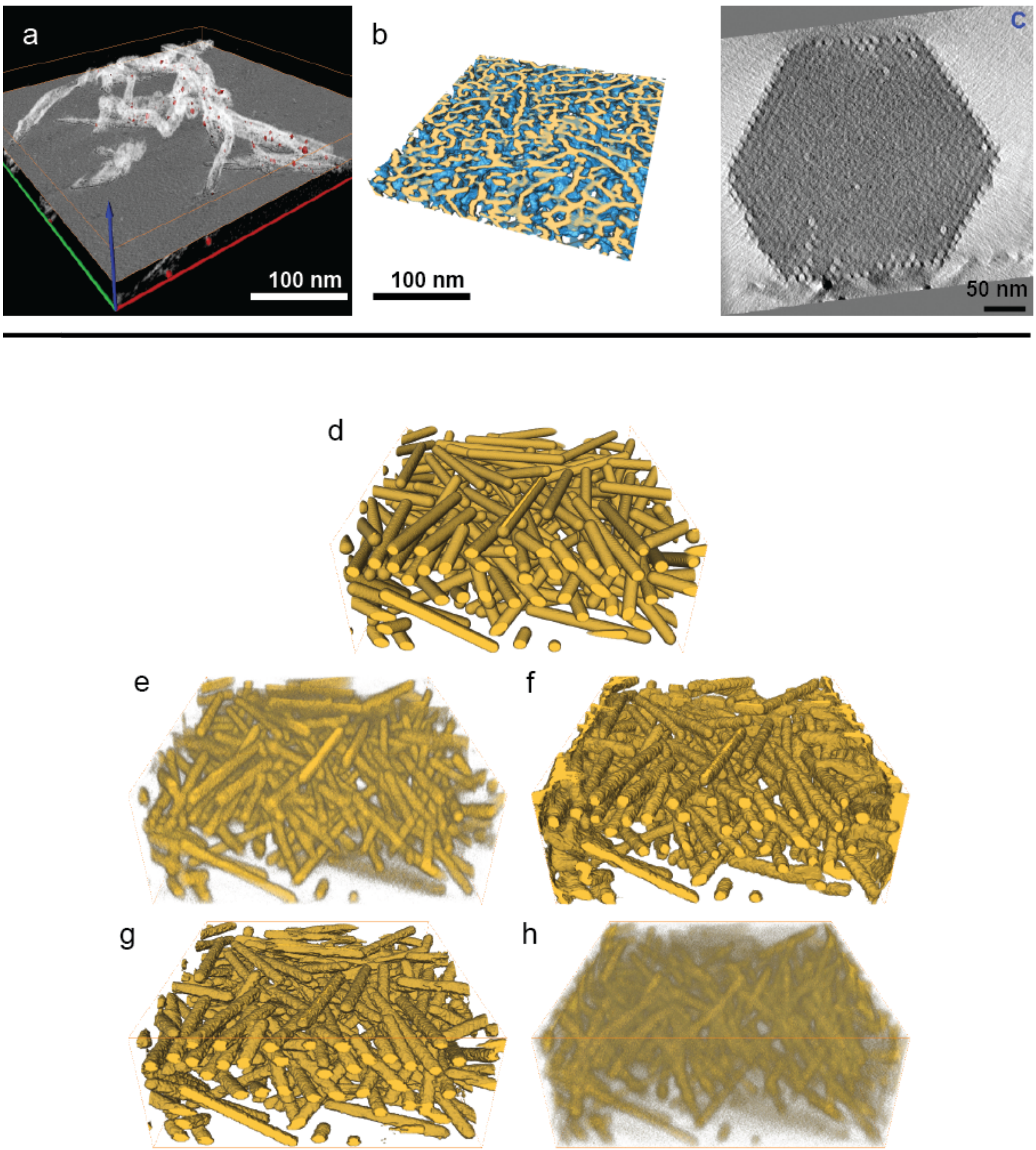

Fig. 1: Quantitative 3D imaging examples: (a) Ru/CNT catalyst; (b) P3HT/PCBM bulk heterojunction; (c) infiltrated and dried SBA-15 crystallite; (d) simulation model to determine ET resolution and reconstructions using (e) SIRT; (f) TVM; , DART (d), and WBP (e) at a total electron does of 104 e/Å2 and tilt increments of 1°.