Mesoscale Priority Research Direction

Design and control of interfaces in soft materials

Opportunity

Transformative technologies based on disordered soft electronic materials, from light-emitting transistors, to photovoltaics and electrochemical cells to chem/biosensors, all rely on organic interfaces to control the important fluxes and conversion of charge and/or energy. The present-day inability to engineer and control the functionality of various interfaces in these 'soft' materials is a key bottleneck on the path toward the next generation of organic electronic devices.

Meso Challenge

- Synthetic control over the interface energetics;
- Engineering of specific functional defects;
- Minimizing thermal losses in the process of energy conversion 'light quanta' – 'exciton' – 'charges';
- Manipulation of long-range collective behavior and competing interactions;
- Achieving desired materials inhomogeneity and disorder, from molecular to meso-scale;
- Engineering of hybrid interfaces (organic/metal, organic/semiconductor).

Approach

- Experimental electronic and optical probes providing simultaneous spatial- and time- resolution;
- Synthesis allowing engineering and continuous modification of interface structure and properties;
- Characterization providing interface structure with atomistic resolution;
- Theoretical approaches spanning multiple length- and time- scales, from first principles methods to classical molecular dynamics to coarse-graining approaches;
- Exploit 'smart', 'self-healing', 'self-assembling', 'bio-mimetic' material's design strategies.

Impact

Next generation functional electronic materials based on low-cost organic (partially)amorphous structures for high efficiency energy harvesting and conversion, efficient light emission, optoelectronics, radiation detection, sensing, imaging, etc.

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