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Imaging Defects and Electronic Disorder in Organic Semiconductors

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The central thesis of this talk is that many structural defects in crystalline organic semiconductors have surface potential signatures that can be recorded and imaged by scanning Kelvin probe microscopy (SKPM) with sub-100 nm resolution.[1-5] This allows straightforward visualization of defects that are difficult to detect by other methods. Additionally, we argue that surface potential fluctuations are a direct measure of static electronic disorder, namely band edge variations, that will impact electron and hole transport. Thus, surface potential imaging not only reveals defects in crystalline organic semiconductors but importantly provides a direct link to electronic disorder (e.g., traps, scattering centers) that degrade transport performance. This talk will focus on three illustrative examples based on thin films and single crystals of benchmark organic semiconductors,[2,4,5] including one case where we can make a thorough connection between structure, surface potential, and field effect transport.[5] We propose that in many cases the surface potential contrast associated with a given defect arises due to inhomogeneous strain around the defect. To support this, we further describe the first direct measurements of the strain-surface potential relationship for macroscopic single crystals of rubrene.[3] Overall, we suggest that surface potential measurements are a powerful approach to understanding correlated structural and electronic disorder in soft organic semiconductors.

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References

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