Delivery of a Practical Tool for Predicting the Effect of Solvents & Growth Inhibitors on Crystal Morphology

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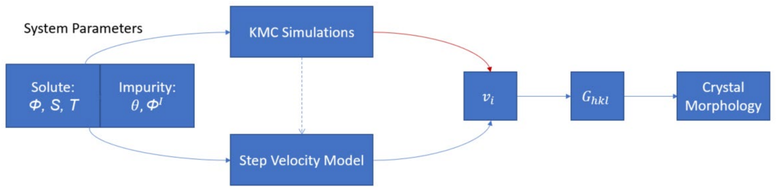
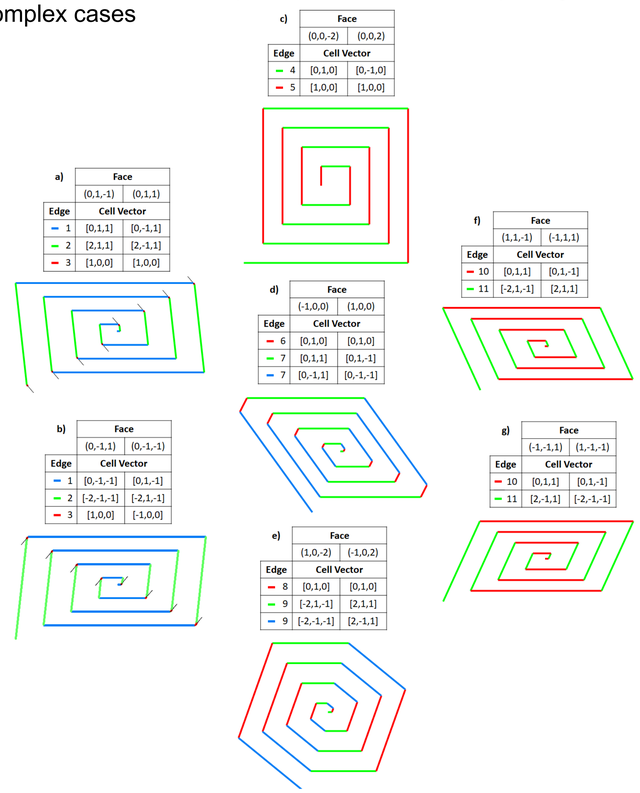
Objectives

- Develop a practical engineering tool for predicting the relative growth rates (growth kinetics) and morphology of solution-grown faceted crystals, including the effects of solvent, and impurities/additives

Morphology Prediction Framework



- Kinetic Monte Carlo (kMC) simulations offer an alternative path as a method to determine step velocities and thus morphologies for more complex cases



- We may identify the unique edges required to simulate (11 for adipic acid) and readily incorporate this methodology within ADDICT's workflow

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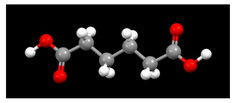
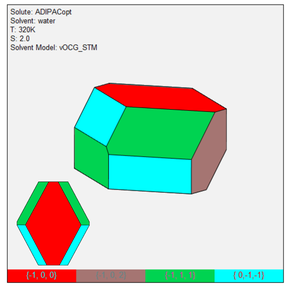
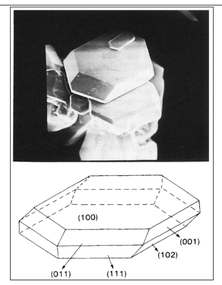
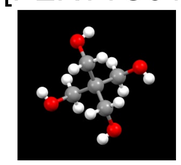
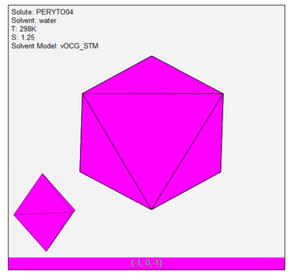
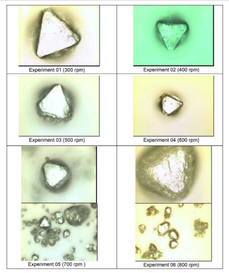
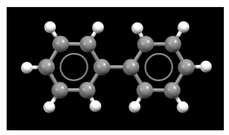
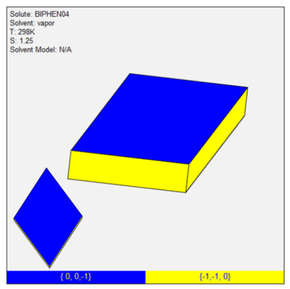
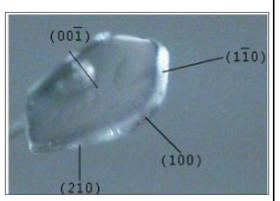
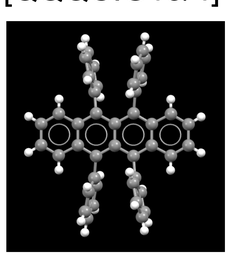
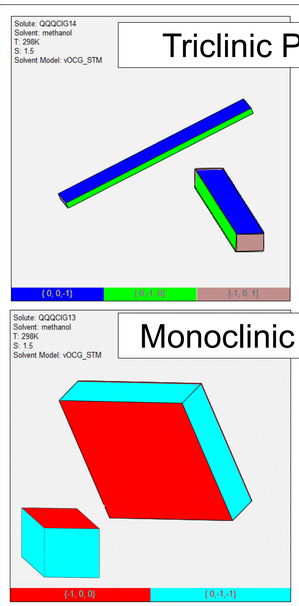
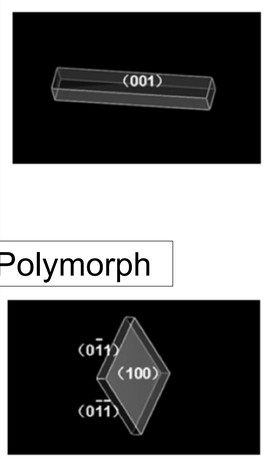
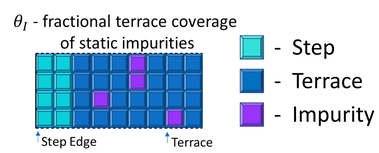
Centrosymmetric Morphology Predictions

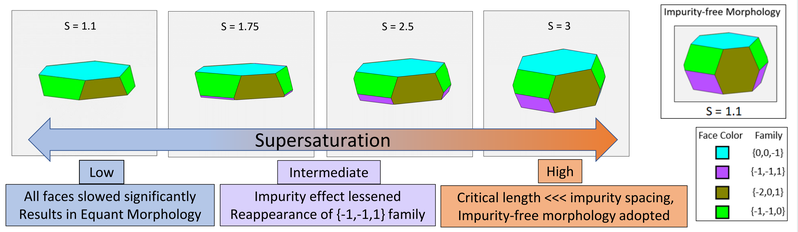
Crystal Species/Solvent	kMC-Based Morphology Prediction	Experimental Morphology
Adipic Acid [ADIPAC]  Solvent: water		 Davey, R. J. *et al. J Chem Soc Faraday Trans* **88**, 3461–3466 (1992).
Pentaerythritol [PERYTO04]  Solvent: water		 Bernardo, A. & Giulietti, M. *Chem Eng Res Des* **88**, 1356–1364 (2010).
Biphenyl [BIPHEN04]  Grown from vapor		 Tilbury, C. J., Green, D. A., Marshall, W. J. & Doherty, M. F. *Cryst Growth Des* **16**, 2590–2604 (2016).
Rubrene [QQQCIG13/4]  Solvent: methanol		 Huang, L. *et al. J Mater Chem* **20**, 159–166 (2010).

Introducing Complexity

Impurity-Mediated Crystal Growth



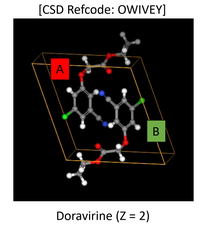
- Terrace-bound impurities serve as static "blockers" and pin the step



Noncentrosymmetric Growth Units

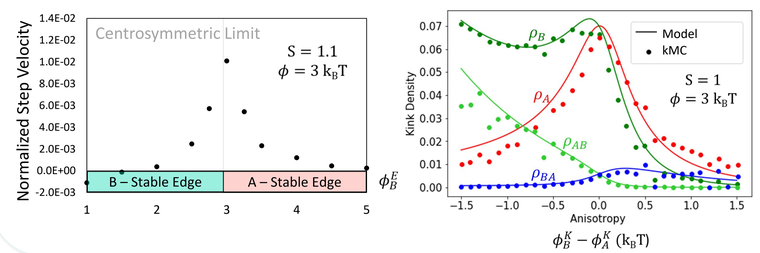
The lack of an inversion center presents modelling challenges:

1. Complex PBCs – bonds comprising a single bond chain are not necessarily of the same strength.
   - Same molecule can act as *different growth units!*
2. Kink Rates – there exist >1 type of kink site so there is no longer an isotropic driving force to incorporate into the solid state structure
3. Stable/Unstable Edges – complex bonding structures introduce the idea that certain edges may not be stable



Doravirine (Z = 2)

- Recent kMC developments allow us to simulate the noncentrosymmetric cases and compare to novel models



Future Work

- Complete kMC simulations for AB crystals with and without impurities in solution
- Non-equilibrium kink density model is finished - write "special code" for AB systems; ADDICT – test + compare with experiment and kMC
- Extend COSMO-SAC to solvent mixtures (antisolvent crystallization)

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