Is Fracture Toughness Useful for Linking Processing Conditions to In-Service Requirements?

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Presented by Anoush Poursartip

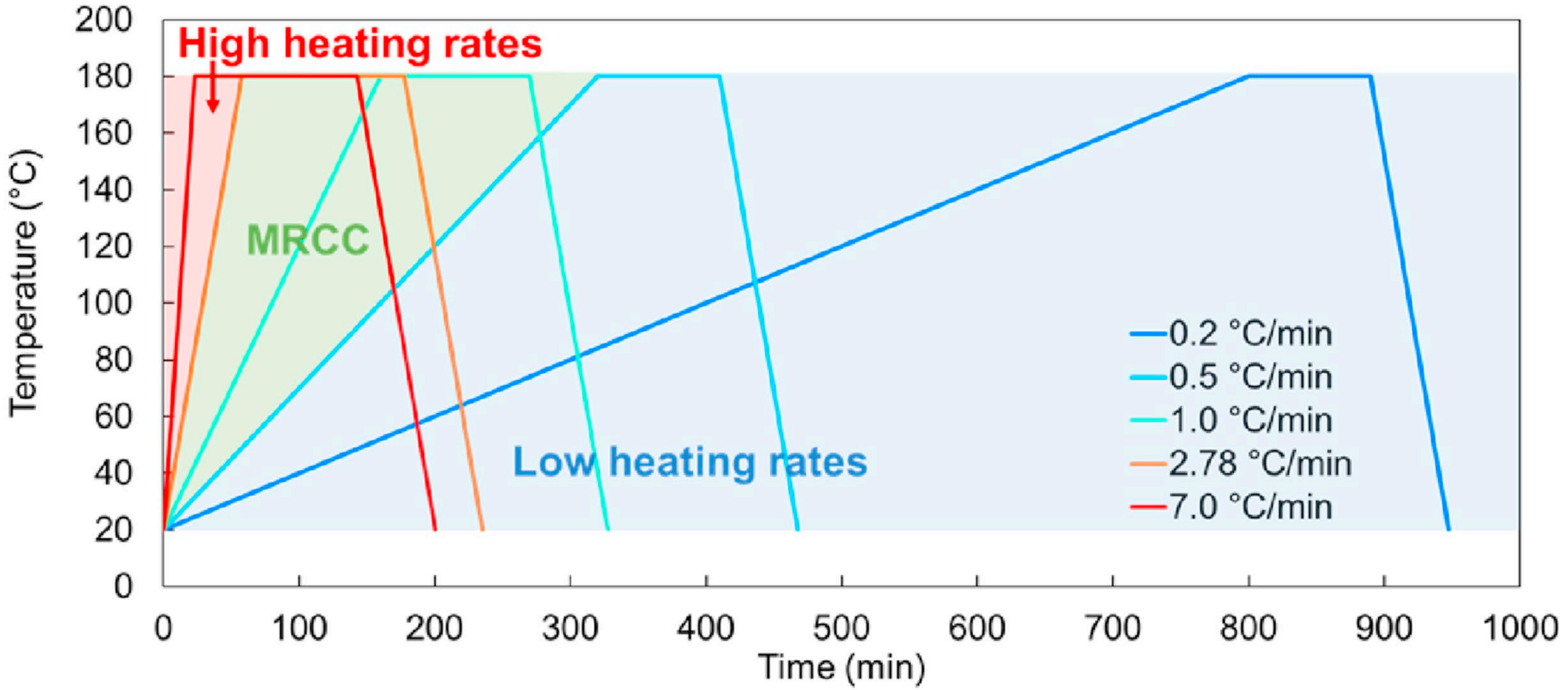
Introduction

- For convenience, we focus on thermoset matrix composites
- We take as read all concerns and caveats regarding what a ‘material property’ means
- Our interest in this short presentation is the classic materials science relationship

- We take as agreed that changing the raw material, e.g. fibre, fibre volume fraction, layup, … will change fracture toughness, both interlaminar and in-plane
- Our interest here is to consider what might be considered second-order process effects, of which cure-cycle path dependency is an increasingly important one

Path Dependency of Interlayer Toughened Thermoset Composite

- Toray T800SC/3900-2B



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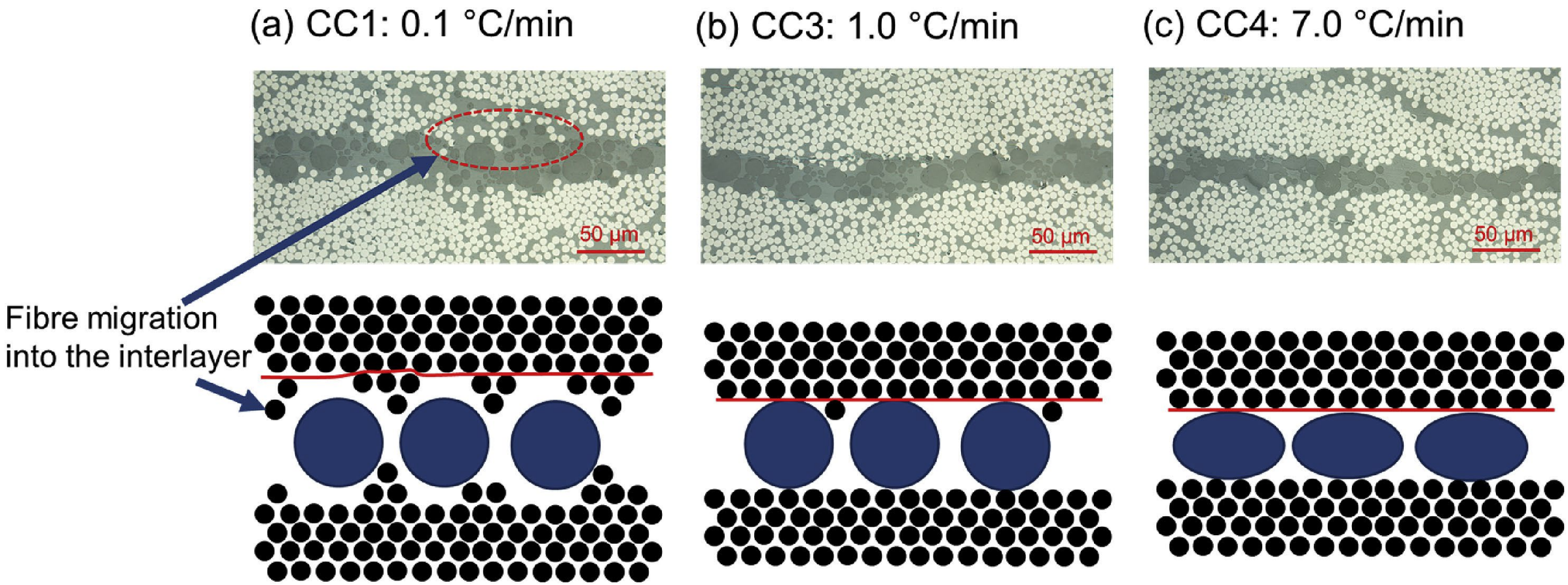
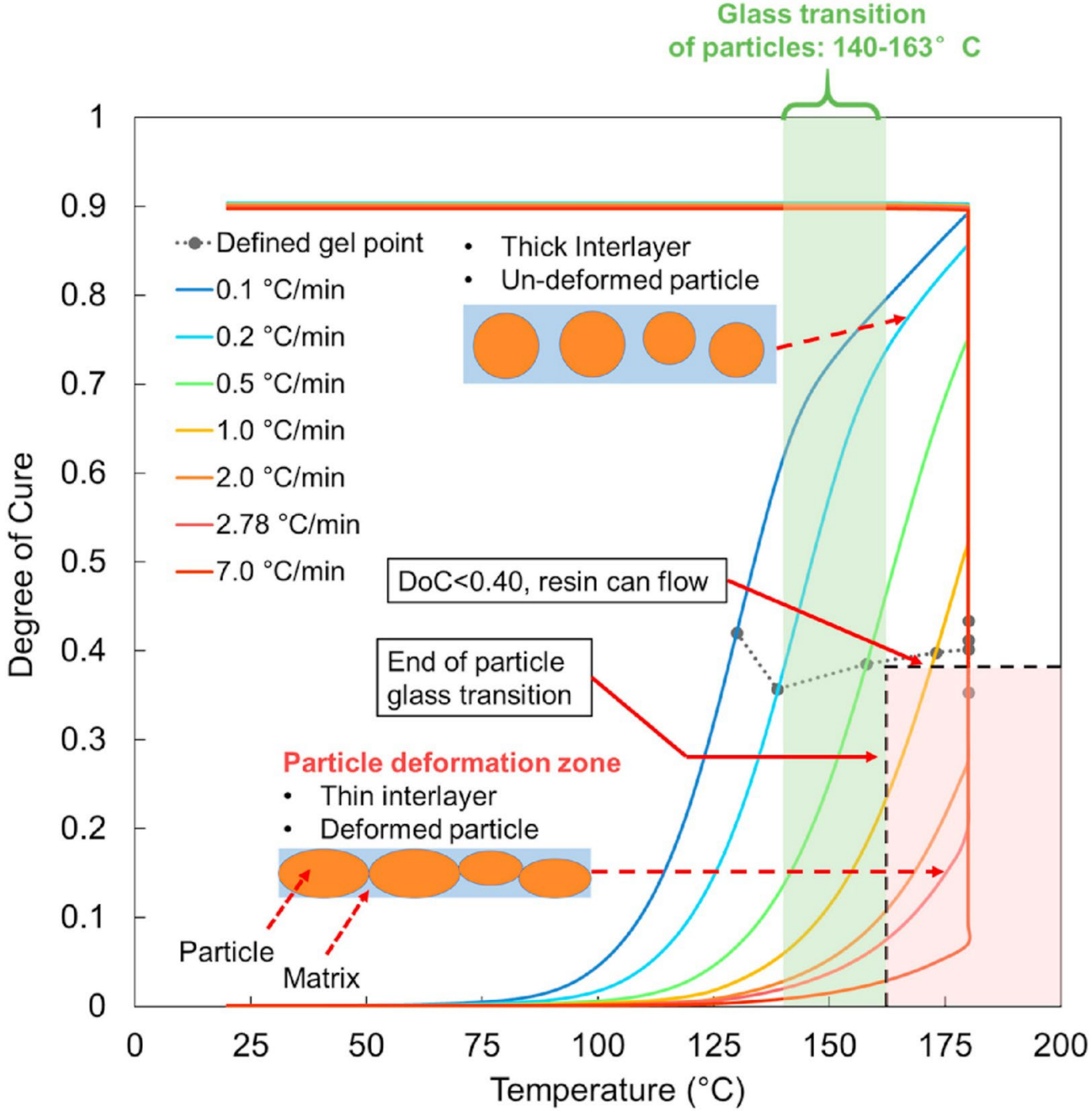
Interlayer Morphology as a Function of Temperature Rate





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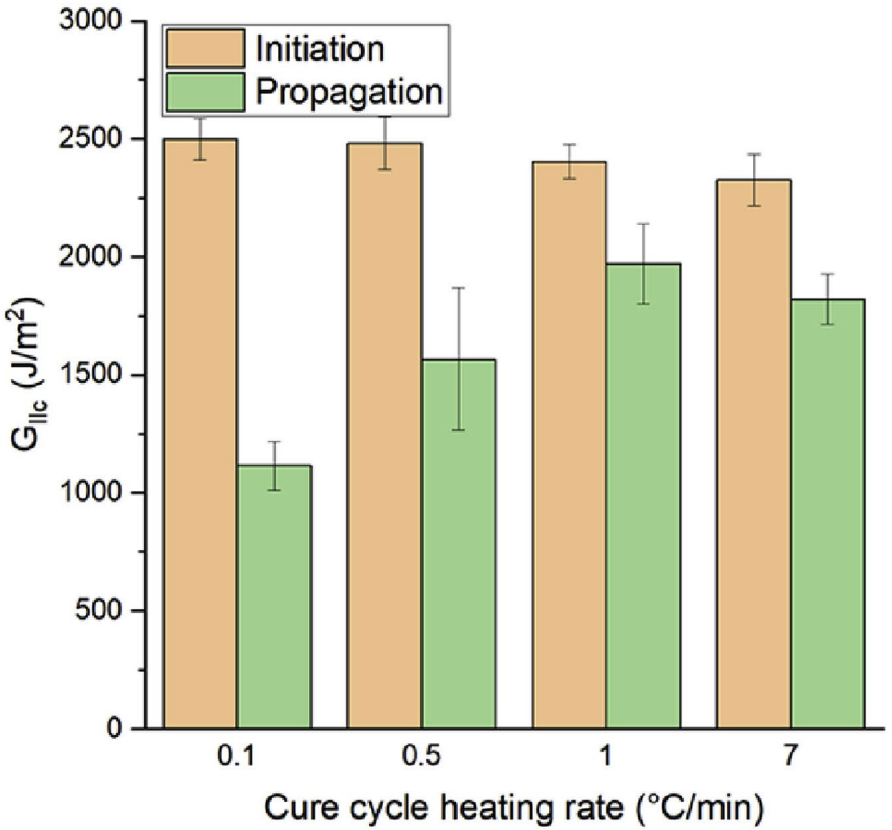
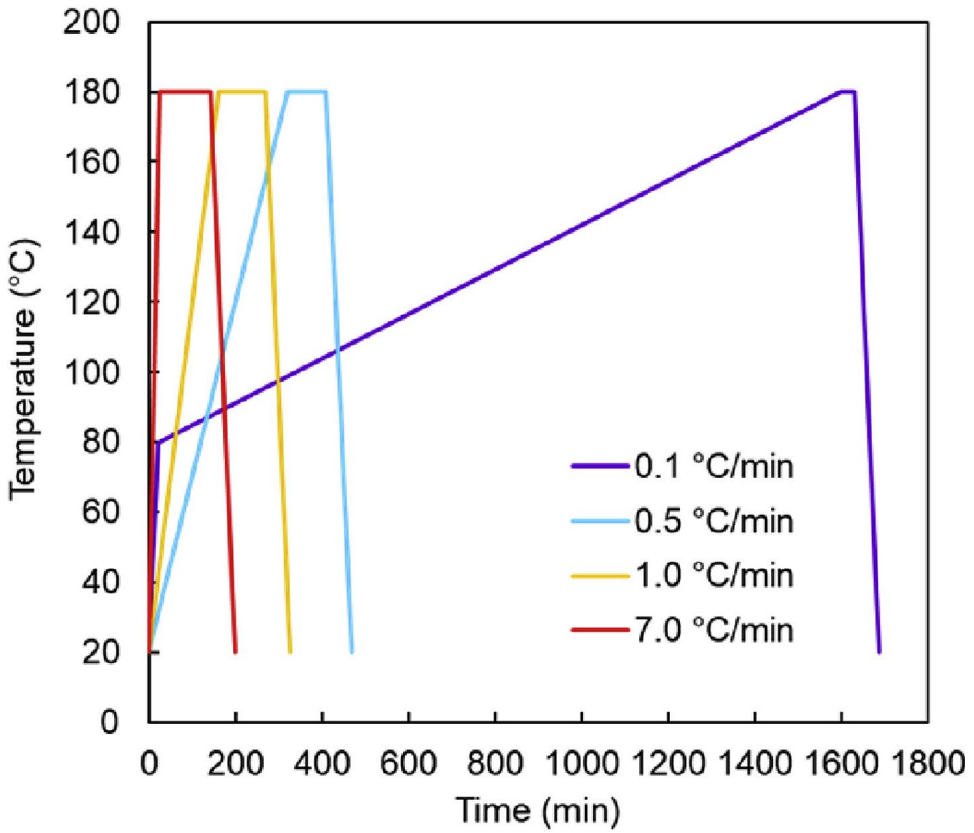
Effect of Temperature Ramp Rate on G_{IIc}





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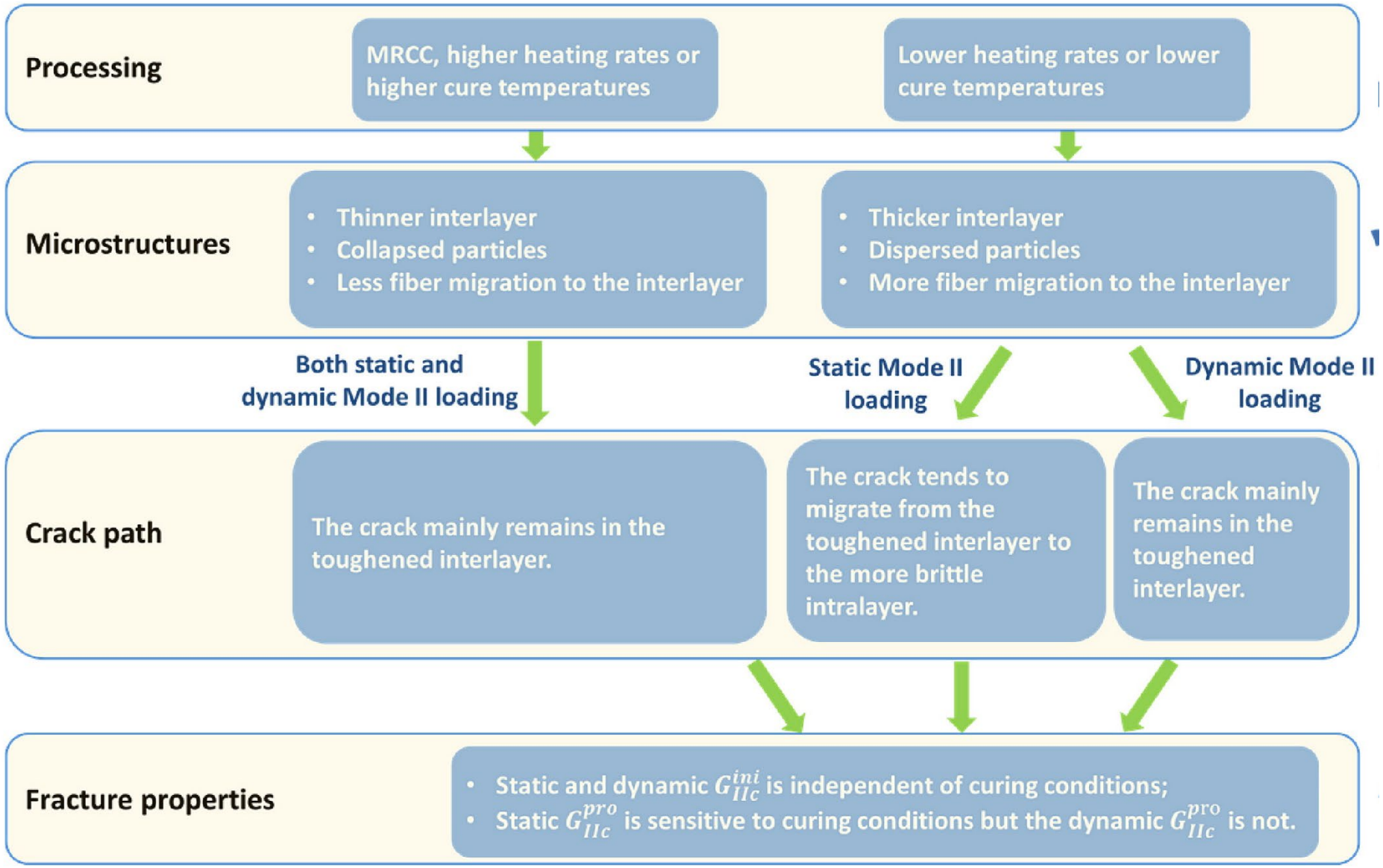
Process-Structure-Property Relationship for Fracture Properties



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Summary and Conclusions

- What may appear as minor changes in processing conditions can significantly change morphology, particularly in latest-generation composites.
- The morphology changes can be subtle yet impact fracture and failure propagation significantly.
- So long as fracture toughness is defined broadly and completely, e.g. Mode I vs Mode II, initiation vs propagation, static vs dynamic, then fracture toughness is a useful concept.
- Although the work presented here focused on interlaminar toughness, clearly this behaviour scales up to and explains in-plane fracture toughness.
- We have only scratched the surface of the interactions between process and properties, and this is becoming ever more important as we become more adventurous and demanding of improving manufacturing.

References of Interest

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