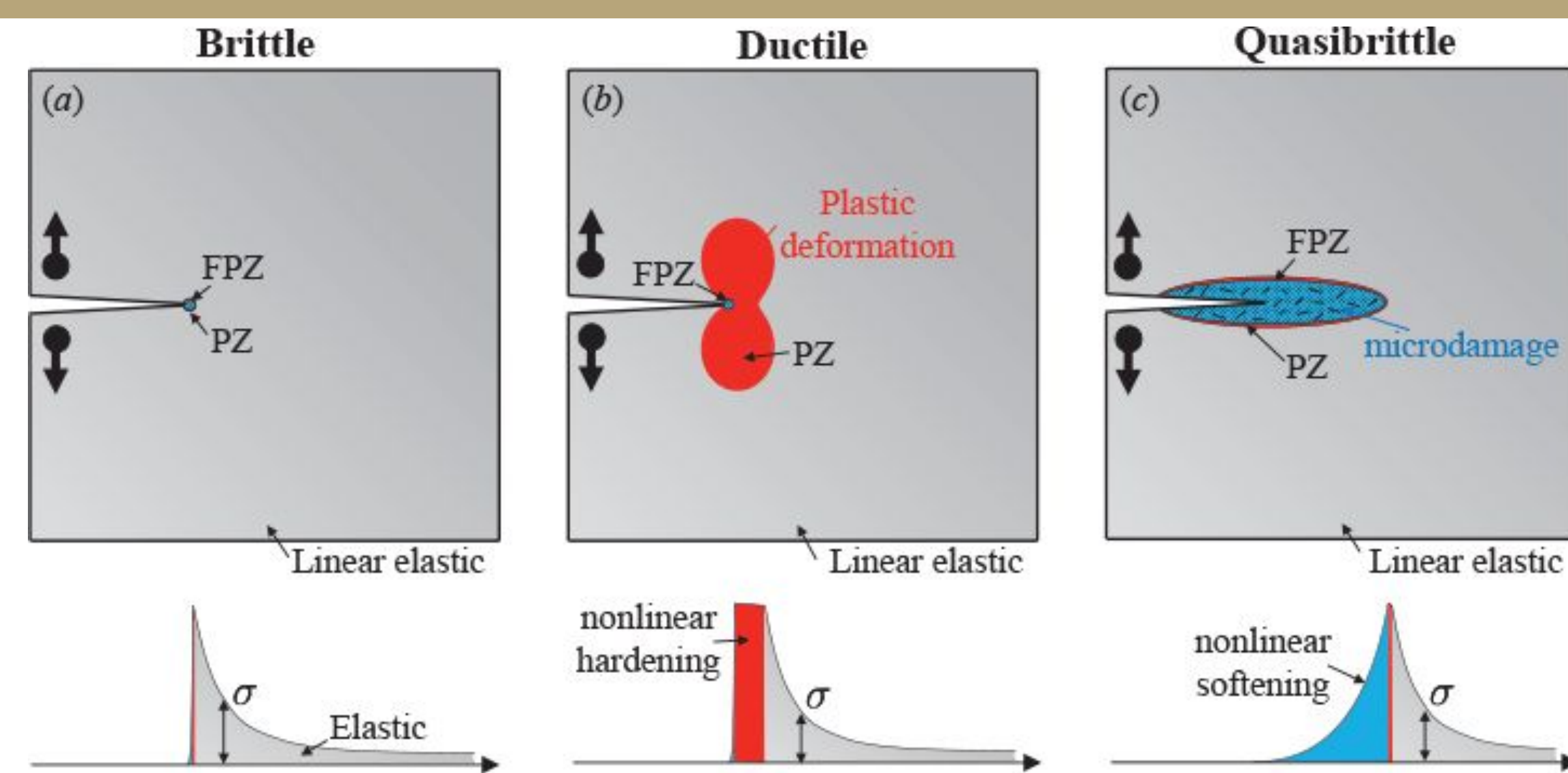




# Quasibrittle Fracture Behavior and Size-Effect of Fiber Reinforced Polymer

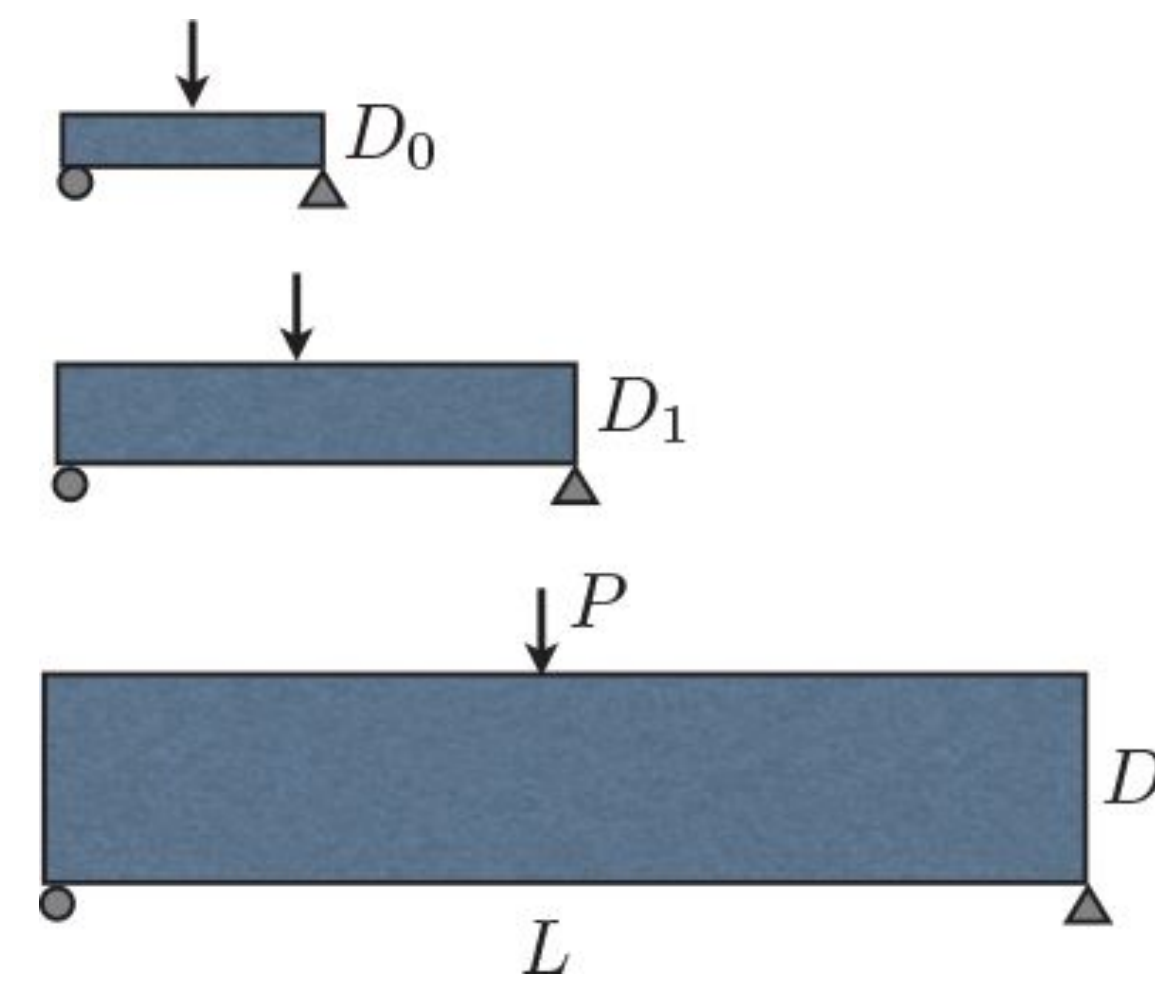
Jiacheng Chen

## Quasibrittle Materials



Unlike conventional brittle materials (e.g., ceramics) and ductile materials (e.g., metals), the quasibrittle materials, represented by composites such as concrete and fiber reinforced polymer, have unique response to a crack. Because of strain softening mechanisms such as microcracks, frictional micro-slips and grain interlocking, the **stress decreases near the crack tip**.

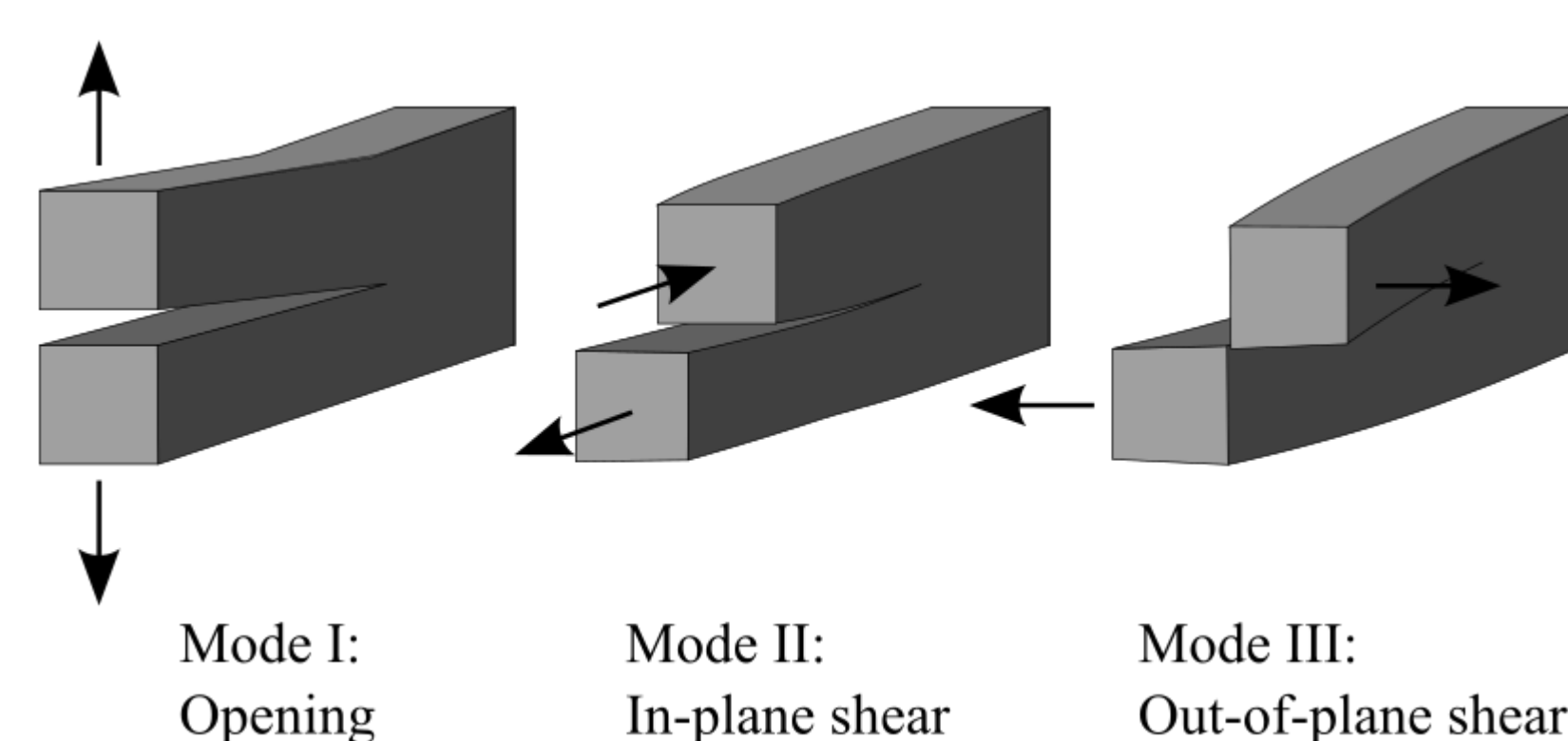
## Size Effect



The zone containing strain softening microstructures is called **Fracture Process Zone** (FPZ). When the size of the structure is comparable to FPZ, the fracture behavior can greatly change.

## Objectives

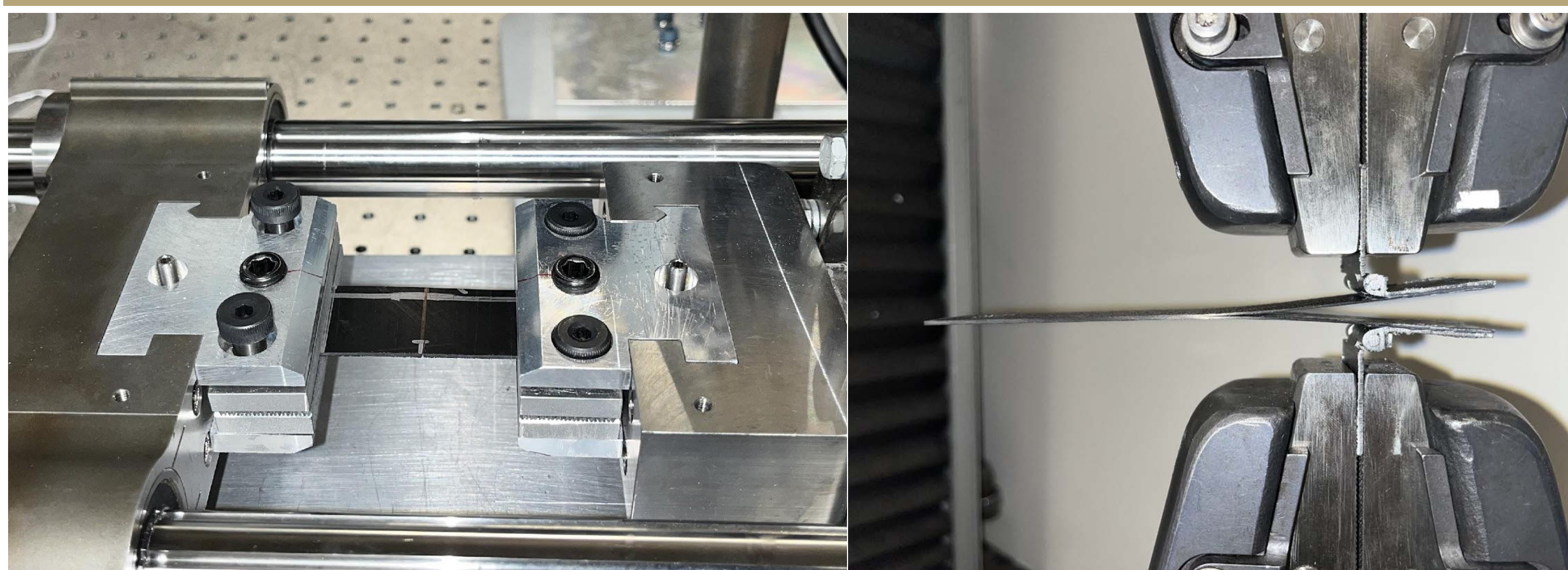
The goal of this study is to determine the fracture behavior of IM7/977-3, a widely used carbon fiber reinforced composite, in different sizes and different fracture modes.



## Coupon Fabrication



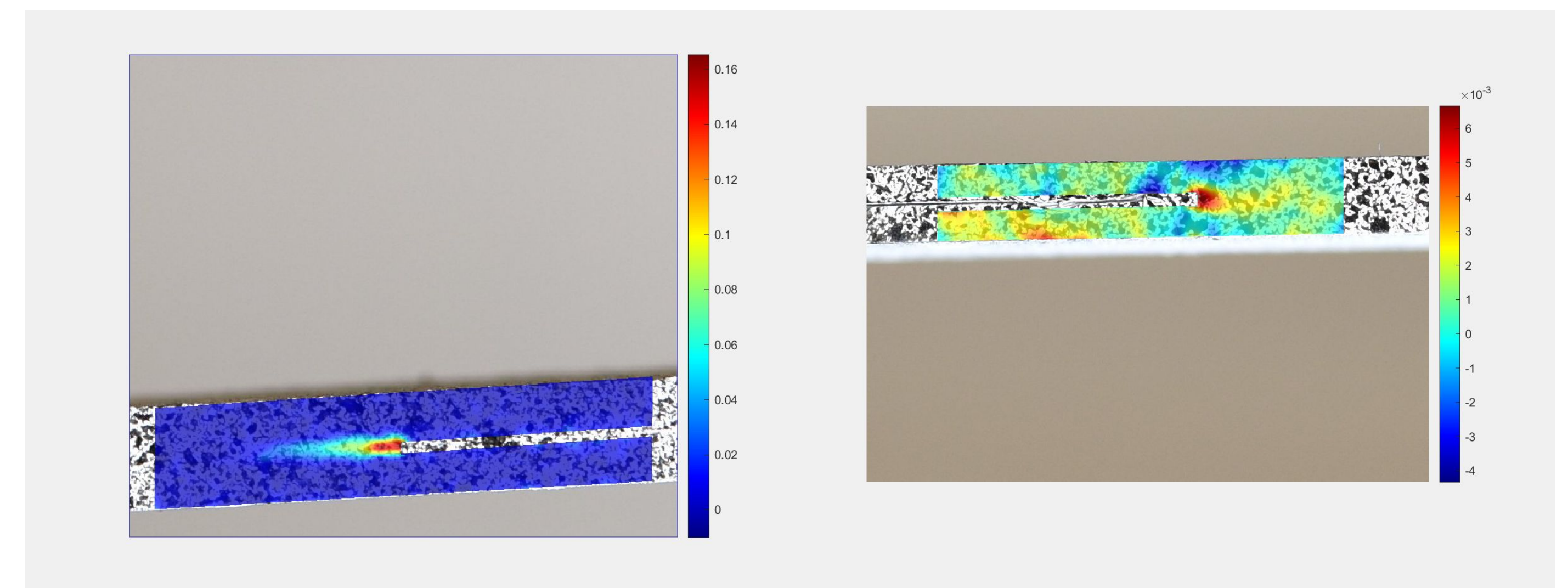
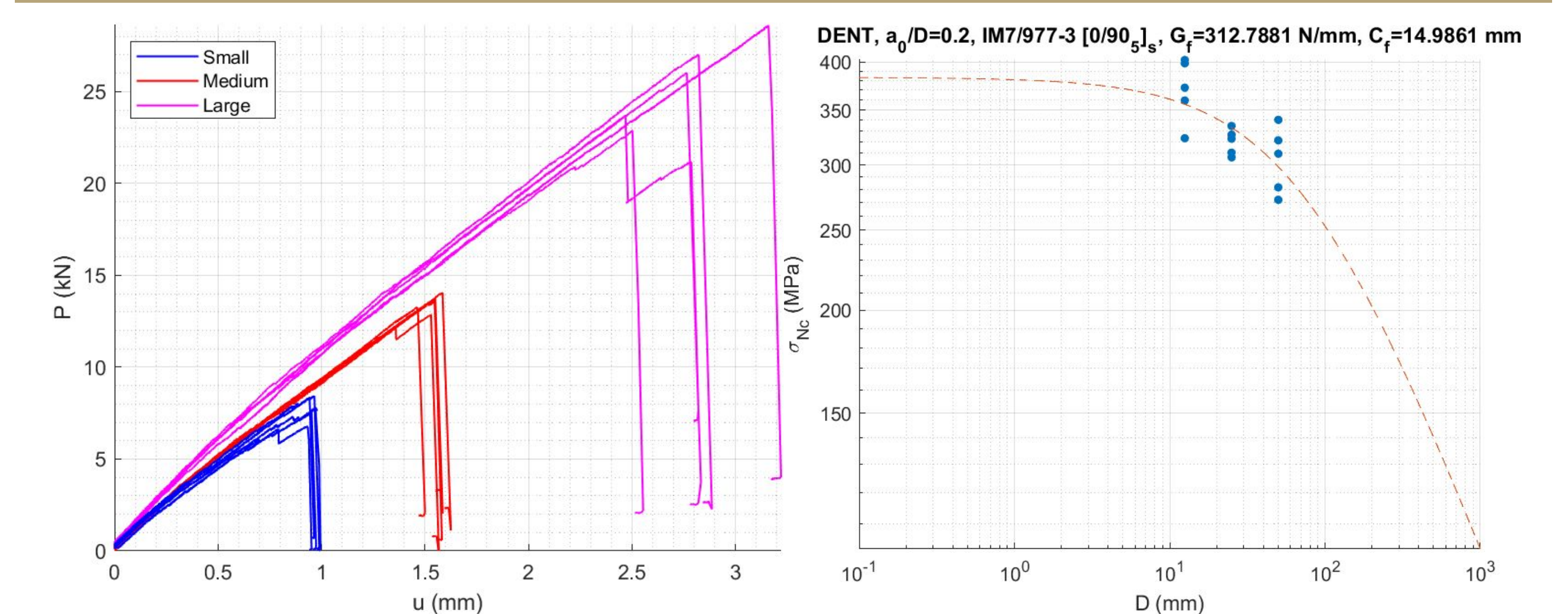
## Testing



Tests are done to investigate the fracture of IM7/977-3 due to:

- Fiber-dominated Mode I
- Matrix-dominated Mode I
- Interlaminar Mode I
- Interlaminar Mode II

## Test Results



- Nonlinear size effect is observed, especially for fiber-dominated Mode I fracture and interlaminar Mode II fracture.
- Due to anisotropy of composite materials, the fracture behavior dominated by different mechanisms have unique fracture energies and FPZ sizes.
- Digital Image Correlation helps to visualize the strain localization near the crack tip.

## Future Work

More tests and analysis can be done to investigate the fracture behaviors dominated by other mechanisms:

- Mode I fracture of  $\pm 45$ -degree plies
- Mode III (tearing) fracture

## References and Acknowledgments

References:  
1. Bažant, Z. P., Le, J.-L., and Salviato, M., *Quasibrittle fracture mechanics and size effect: A first course*, Oxford University Press, 2022.

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