The role of local stress triaxiality in determining the transverse tensile strength of UD composites

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Clarity of concepts

- "Strength", used in engineering is often a descriptive concept meaning "load-bearing capacity".

- In solid mechanics, "strength" is a well-defined quantity representing a critical value at which a prespecified failure event occurs under a uniform single component of stress.

Examples:

Yield strength (Initiation of yielding in a polycrystal)

Ultimate tensile strength (separation in two pieces)

Compressive strength (initiation of kink band in a UD composite)

"Strength" referring to UD composites under uniform transverse stress

- Failure is a process consisting of a sequence of events:

FIRST EVENT: Brittle cavitation (in an epoxy matrix near fiber surfaces)

NEXT EVENTS: Fiber debonding, kink-out, linking of debonds to form a transverse crack
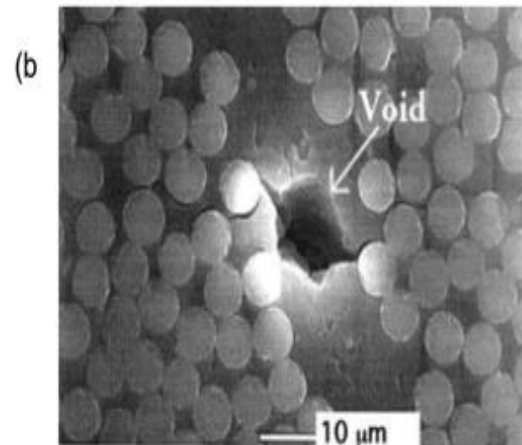
FINAL EVENT: Unstable growth of transverse crack

➢ Testing usually measures only the applied transverse stress at which the FINAL EVENT occurs.

➢ VIRTUAL testing can determine the "strength" associated with the FIRST EVENT

The FIRST EVENT of brittle cavitation is driven by local stress triaxiality, which is a source of variability of the measured strength
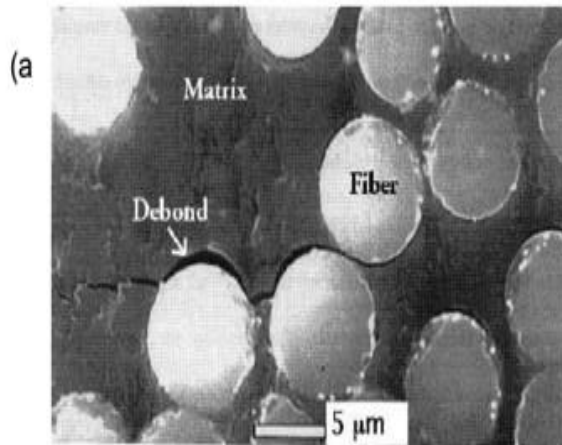
Cracks initiating from weak planes

Cracks initiating from voids