University of BRISTOL

Damage Control in Skin-Stiffened Structures

Rafael Luterbacher-Mus

Supervisors: Prof Ian Bond, Dr Richard Trask

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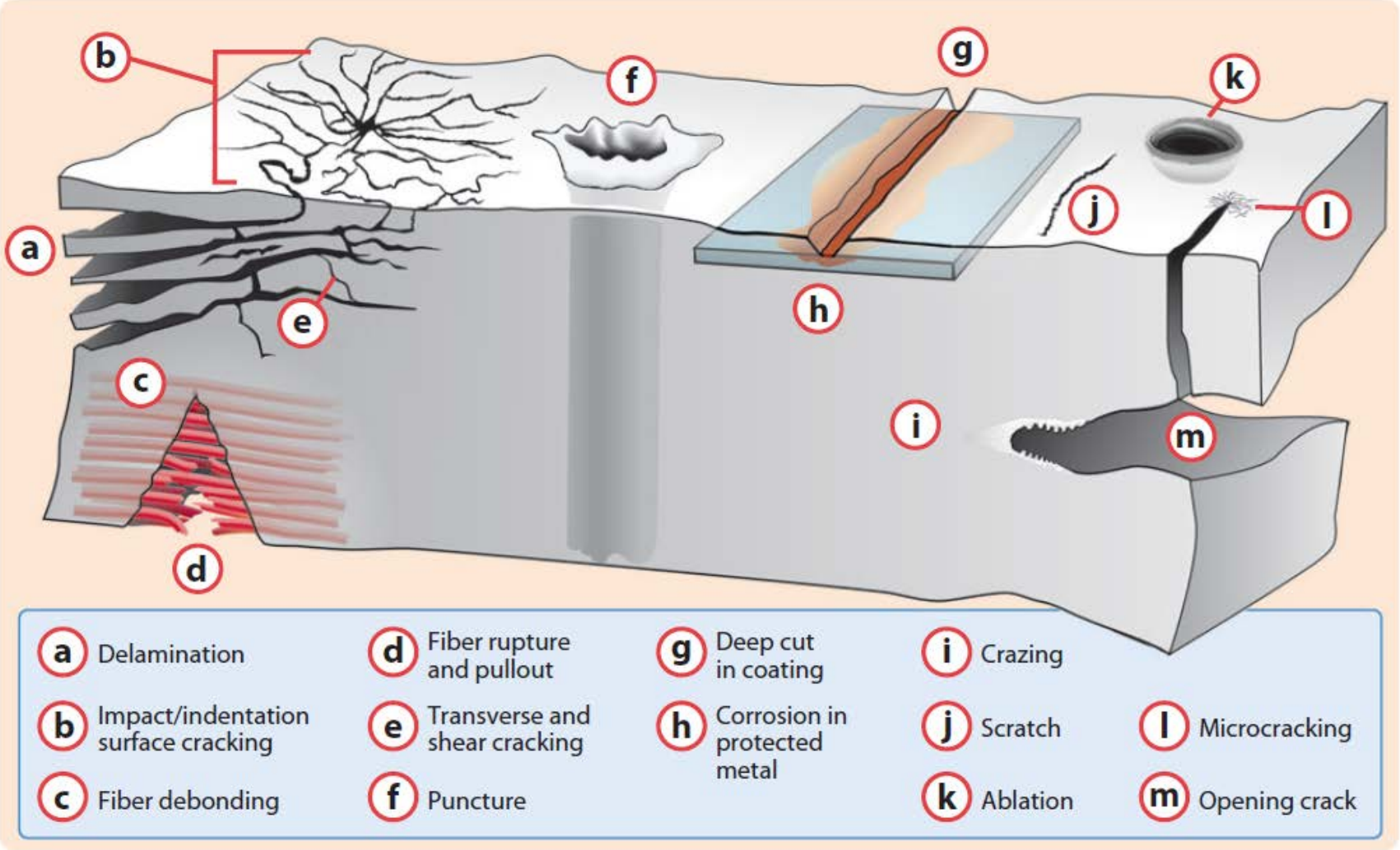
Damage in Composites



B.J. Blaiszik et al.(2010)

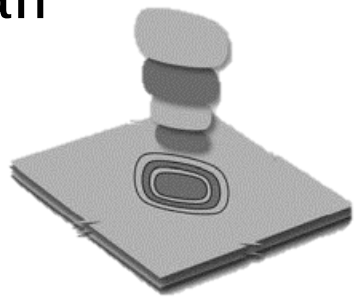
Damage in Composites

No damage growth

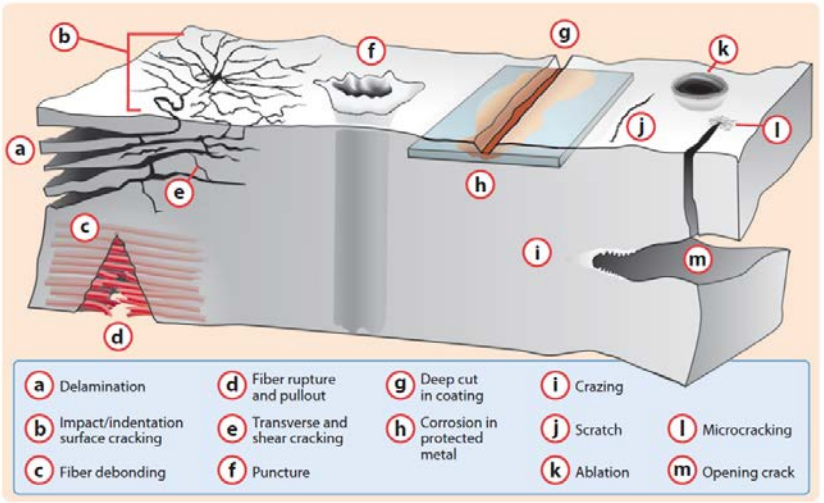
- Safety margins
- NDT

IABG (2014)

- Repair



Katnam et al.(2013)



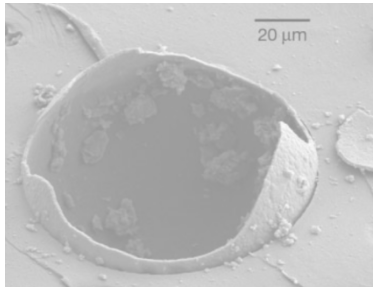
B.J. Blaiszik et al.(2010)

Tolerate damage

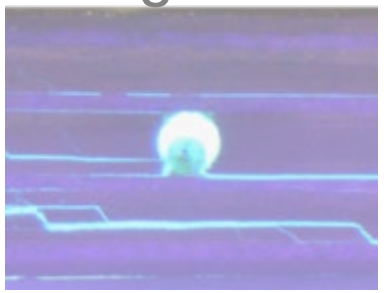
- Weight savings
- SHM

H.Speckmann et al.(2003)

- Self-healing



S.White et al.(2001)



C.Norris et al.(2011)

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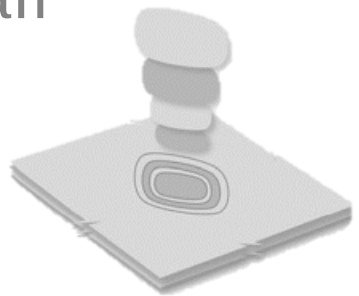

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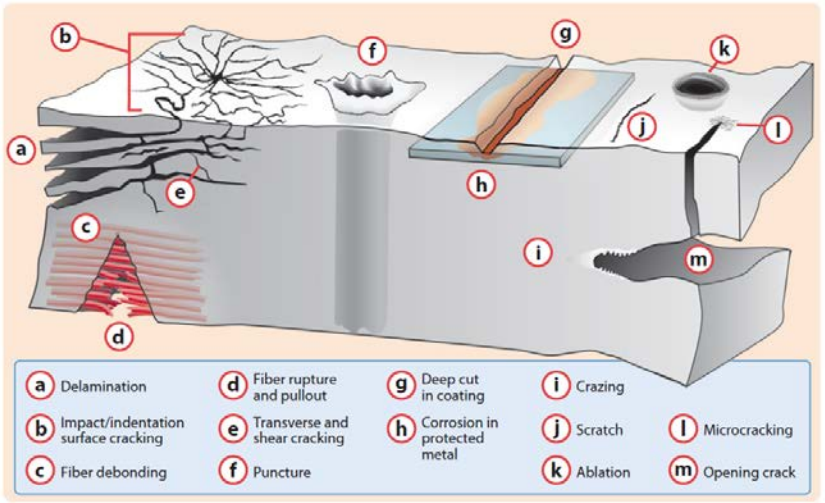

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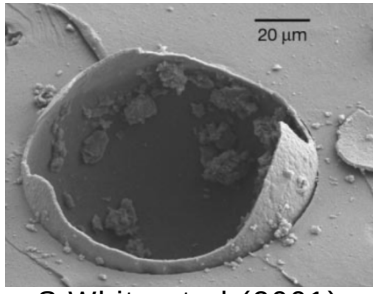
- Self-healing



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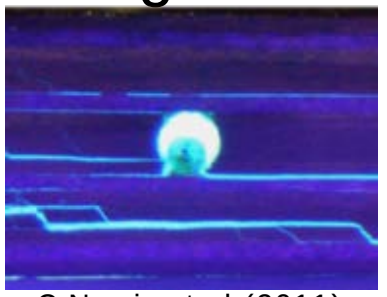
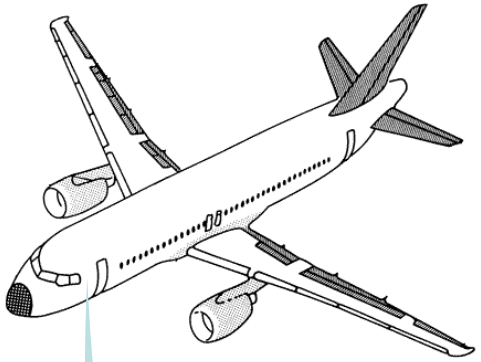
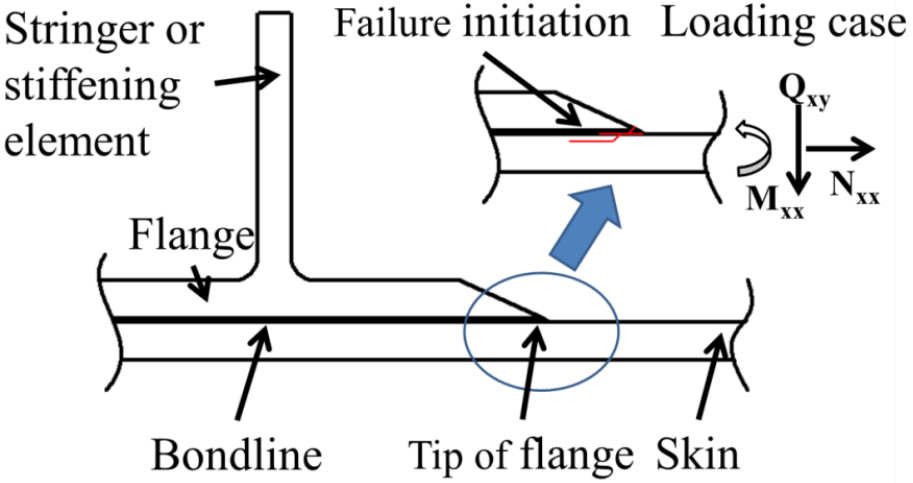


C.Norris et al.(2011)

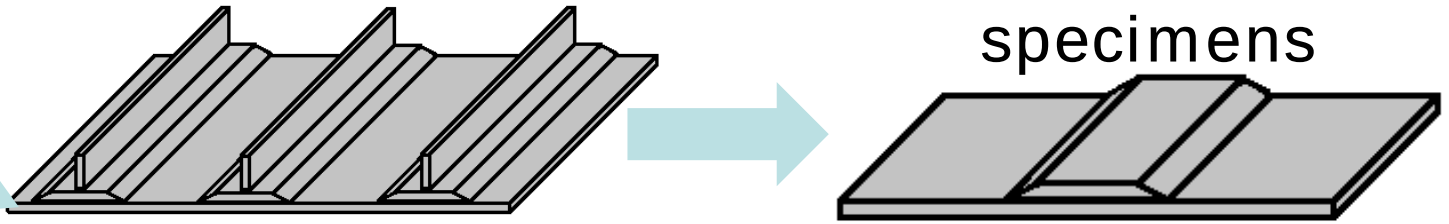
Skin-stiffened structures



Efficient structural solution,
But through thickness stresses arise at flange tip



Skin stiffener debond specimens

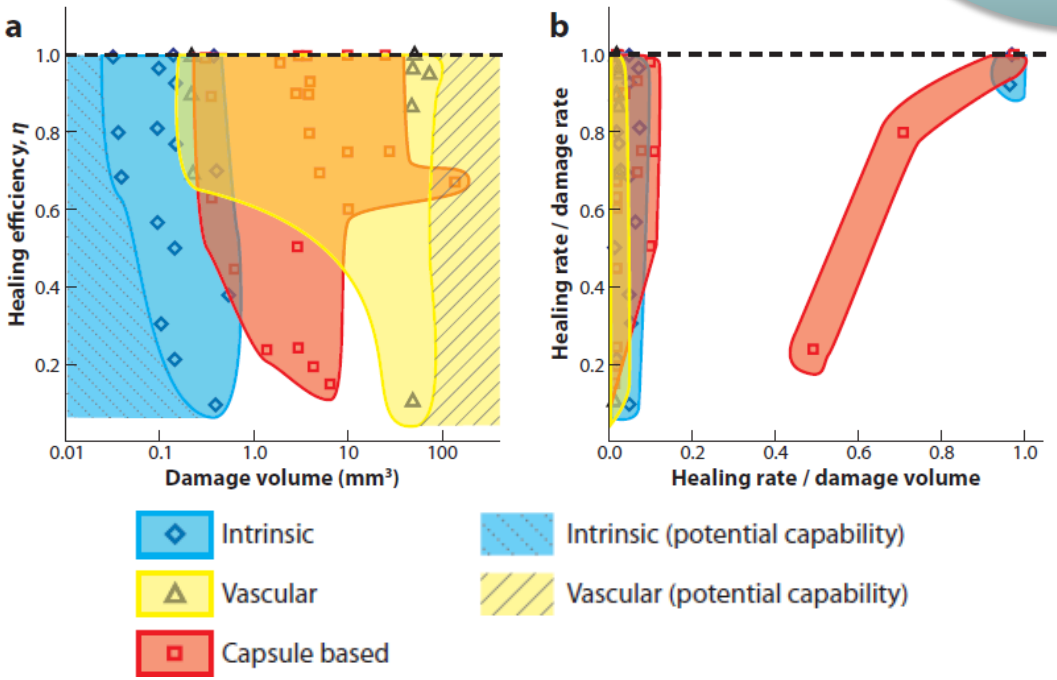


Application to structural features

Adapt self-healing feature to damage pattern

Adapt damage pattern to self-healing feature

- Type of feature



- Damage Redirection
  - *Tolerate and manage damage propagation into self-healing feature*

Damage redirection mechanisms

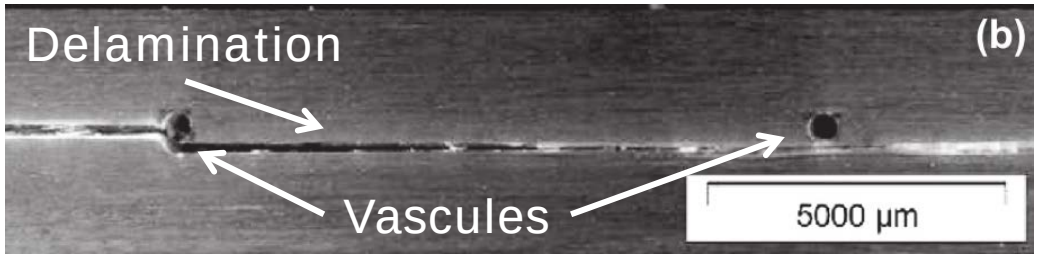
Interleaves | **Vascules** | **Ply Structure**

- Tested in skin-stiffener debond specimens
- Static and fatigue testing

Damage redirection mechanisms

Interleaves | **Vascules** | Ply Structure

Transverse vascules act similar drill holes thereby redirecting delaminations



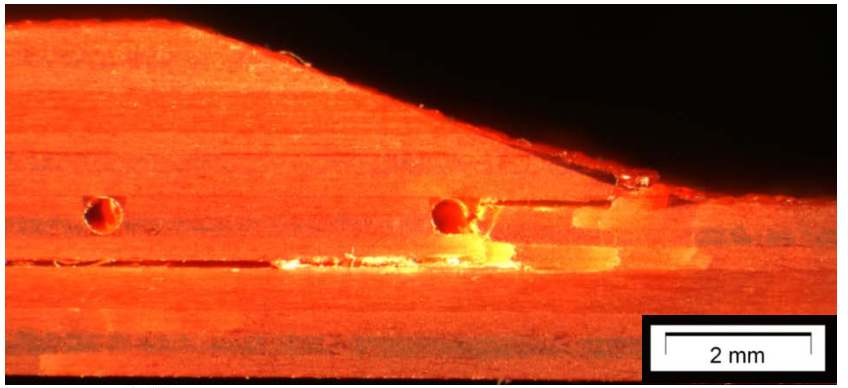
Norris et al. (2011)

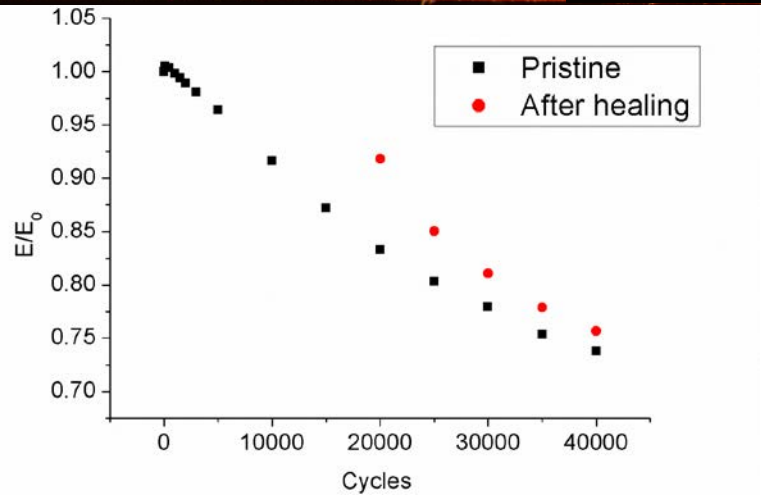
Damage redirection mechanisms

Interleaves | **Vascules** | Ply Structure

Main Results:

- Creation of damage free areas in the specimen
- No difference in global mechanical properties
- Connectivity of vascular network with damage



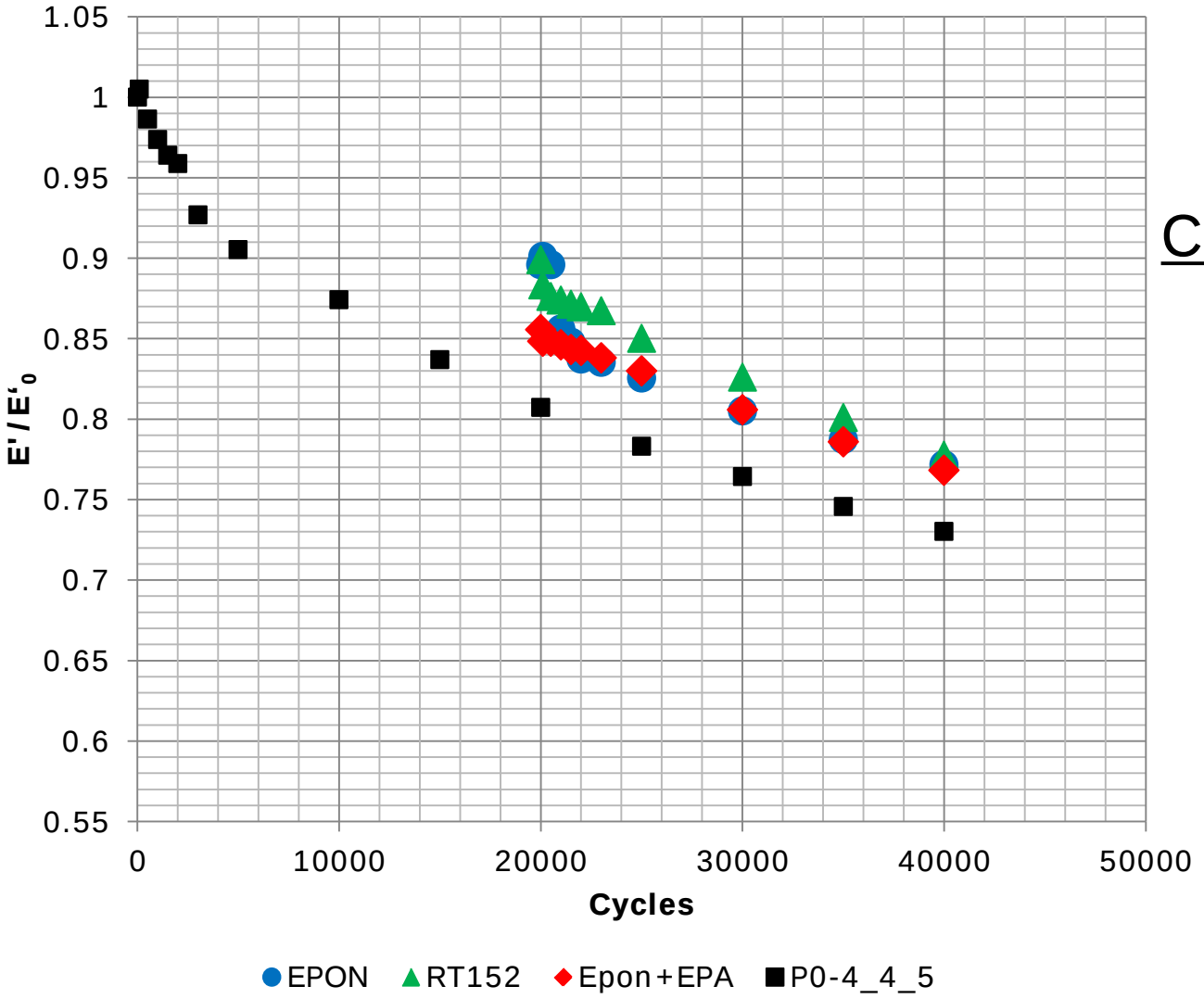


Summary

- Interleaves and vascules do not alter global mechanical performance under static and fatigue loading
- Successful steering of damage with the help of the interleaves, vascules and ply structure into a self-healing feature
  - Damage visualisation
  - Healing
- Fatigue damage successful “healed” and global mechanical properties recovered

	Control through Interleaves	Control through Vascules	Control through Ply Structure
No knock down on static properties	✓	✓	✗
No knock down on fatigue properties	✓	✓	✗
Damage redirection	✓	✓	✓
Healing	?	?	?
Damage visualisation	✓	-	-

Current challenge



<u>Challenge for healing resin:</u>

Trade off between:

Mechanical properties
vs.
Injectability

Acknowledgments

- Ian Bond
- Richard Trask
- ACCIS CDT
- EPSRC
- Fundació Obra Social “la Caixa”

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Thank you for your attention!

Questions?

Rafael Luterbacher-Mus

aerlm@bristol.ac.uk

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