University of BRISTOL

CNT Sheets and Fibres for Multifunctional Aerospace Composites

James Trevarthen

Dr. S. Rahatekar

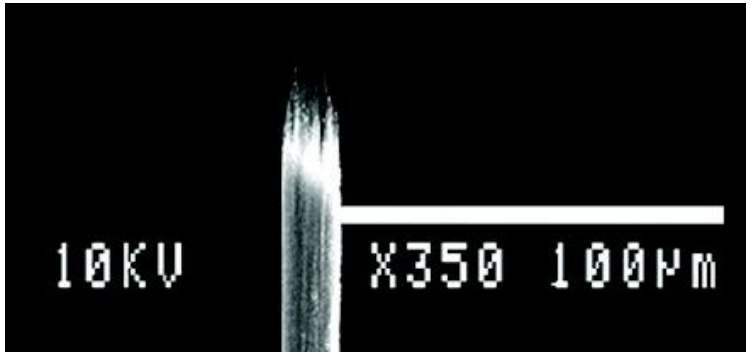
www.bris.ac.uk/composites

accis

ADVANCED COMPOSITES CENTRE FOR INNOVATION & SCIENCE

Introduction

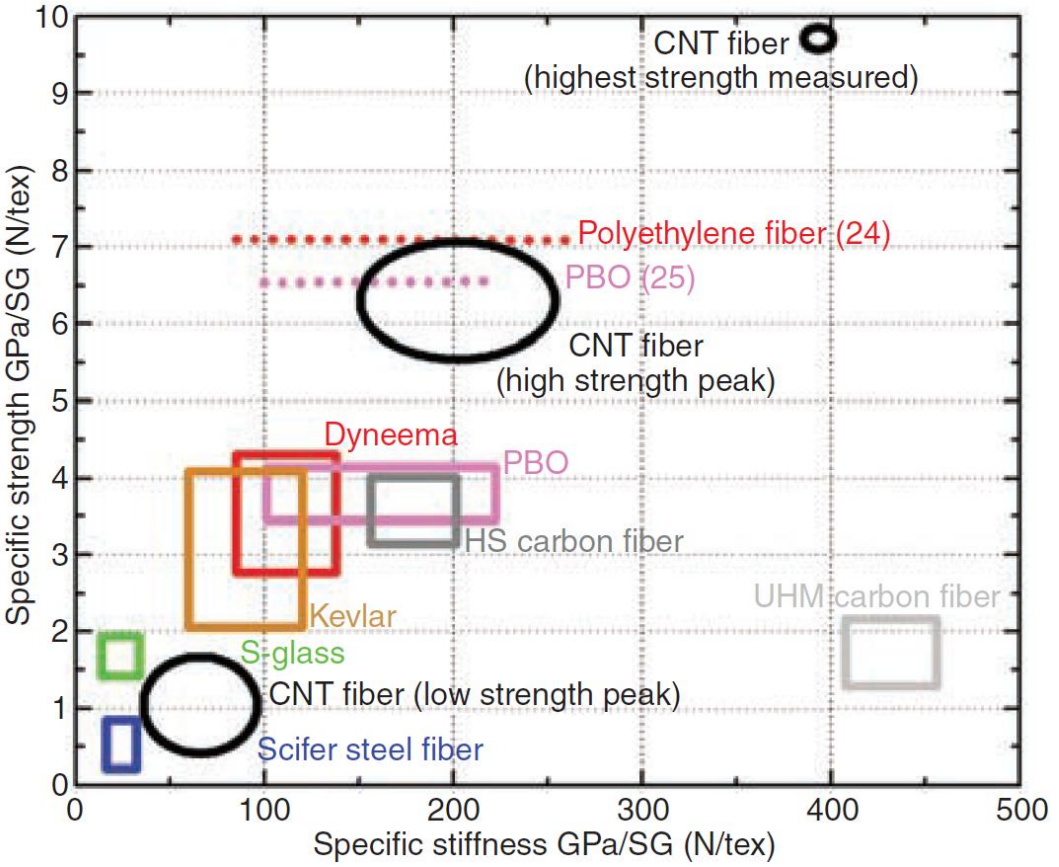
- Carbon nanotube fibres (CNTF) spun from aerogel
- Hierarchic fibre consisting of aligned bundles of CNT
- Mechanical properties rival conventional reinforcement fibres
- Potential to produce high-performance composite
- However, better interfacial understanding required due to discontinuous, porous fibre



SEM of CNTF failed in tension, from Boncel et al., ACS: Nano., 2011

Introduction

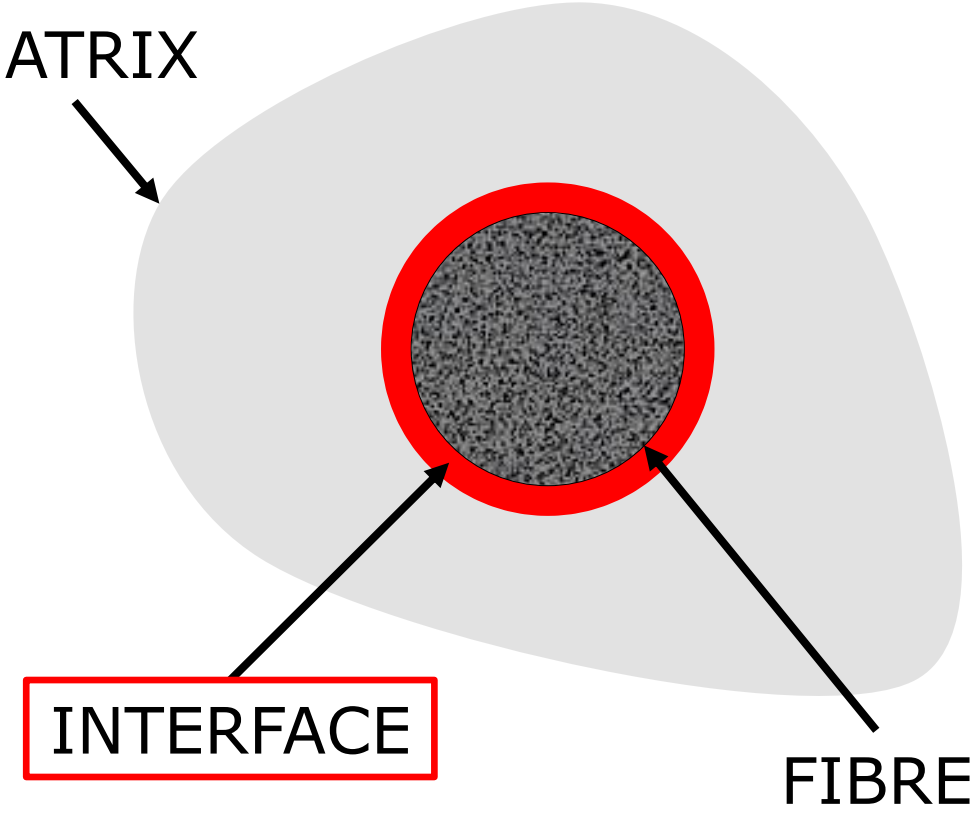
- Carbon nanotube fibres (CNTF) spun from aerogel
- Hierarchic fibre consisting of aligned bundles of CNT
- Mechanical properties rival conventional reinforcement fibres
- Potential to produce high-performance composite
- However, better interfacial understanding required due to discontinuous, porous fibre



Ashby plot of specific strength vs. specific stiffness for reinforcement fibre materials, reproduced from Koziol et al., Science, 2007

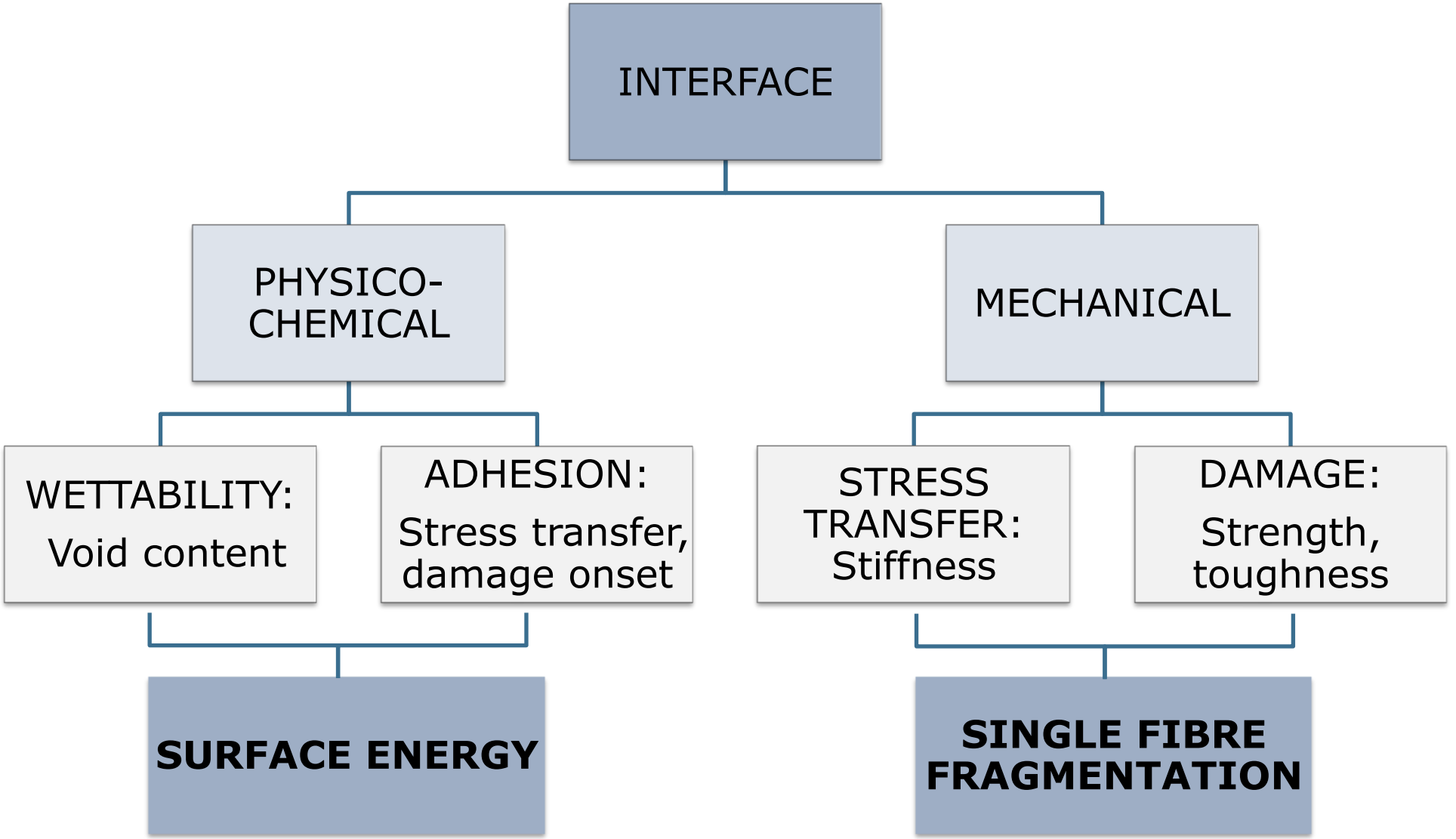
Introduction

- Carbon nanotube fibres (CNTF) spun from aerogel
- Hierarchic fibre consisting of aligned bundles of CNT
- Mechanical properties rival conventional reinforcement fibres
- Potential to produce high-performance composite
- However, better interfacial understanding required due to discontinuous, porous fibre



→ Current Aim

Interfacial Characterisation



Physico Chemical Interface

- Surface energy (γ_{sv}) determined to be 35.2 mN/m
- Tensiometric method:
  - Solid-liquid contact angles estimated from wetting/wicking forces
  - Surface energy determined from Zisman plot (Fig 1.)
- Low relative to conventional fibres
- However, porosity may allow very much greater interfacial area
- Currently working on chemical treatments to improve γ_{sv}

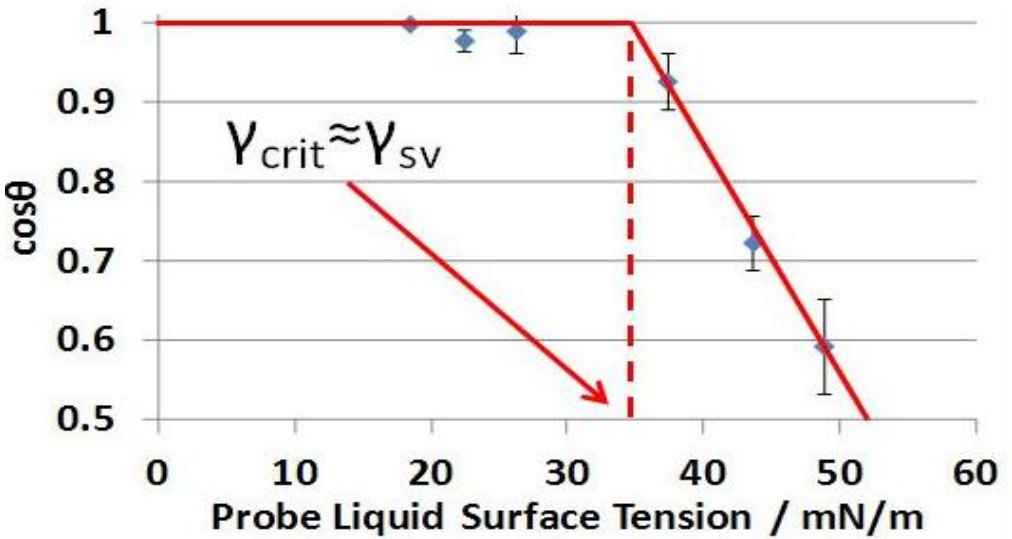
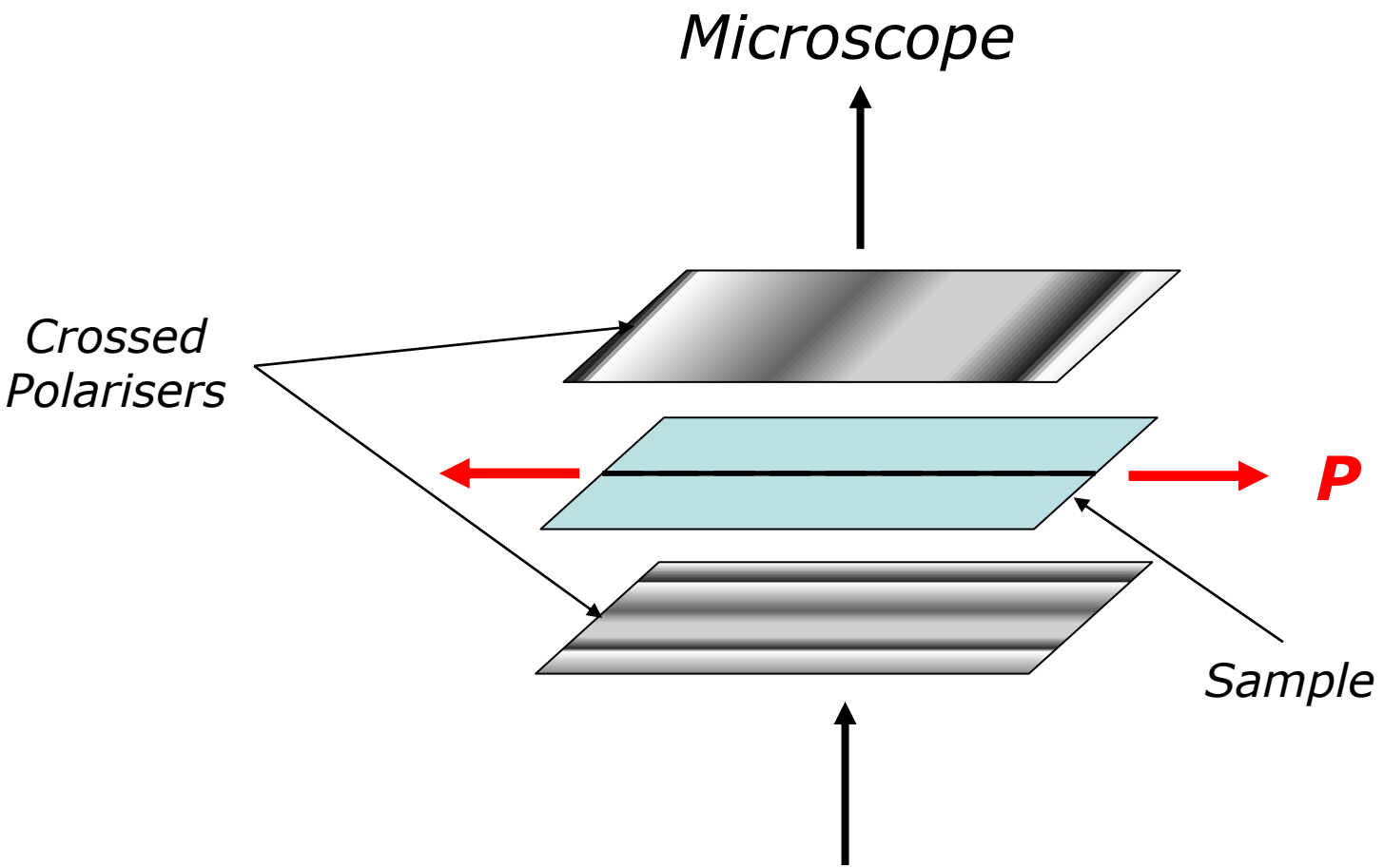


Fig 1. Zisman plot of solid-liquid contact angles vs. liquid surface tensions

Material	γ_{sv} / *mN/m*
CNTF	**35.2**
PE	≈ 32
Kevlar	≈ 41
CF (unmodified)	≈ 40-45
CF (oxidised)	≈ 65-80

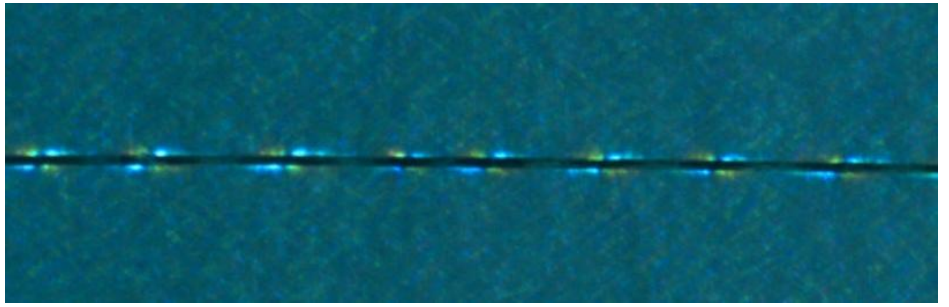
Mechanical Interface



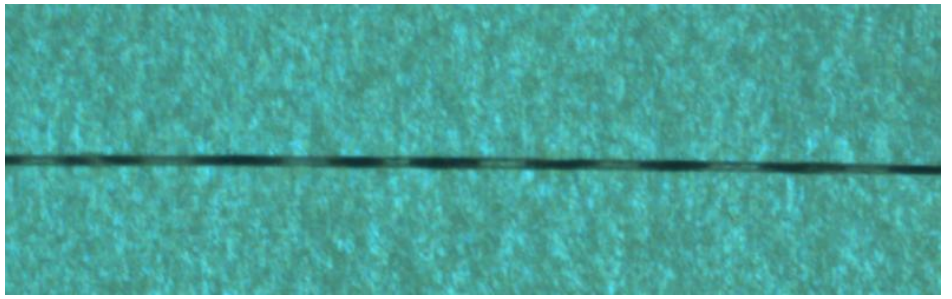
Schematic of SFF Experiment

Mechanical Interface

- Is stress transferred effectively from matrix to fibre?
- Is behaviour of porous, discontinuous fibres similar to conventional, monolithic, brittle fibres?
- Single fibre fragmentation experiment used to answer these questions
- Stress transfer mechanism may be significantly different to monolithic fibres – currently under investigation



Fragmented CNTF with Polariser



Fragmented CNTF without Polariser

Conclusions

- CNTF have potential as reinforcement in high-performance composites if interface is well managed
- Surface energy is very low – work currently under way to improve this
- Efficiency and mechanisms of stress transfer are currently being investigated
- Poster: "Interfacial Analysis of High Performance Carbon Nanotube Fibres"

Acknowledgements:

HiPerDuCT Programme Grant

THE BRISTOL CENTRE FOR NANOSCIENCE AND QUANTUM INFORMATION

UNIVERSITY OF CAMBRIDGE

EPSRC Engineering and Physical Sciences Research Council