Fungal biofilms as low-modulus structural biocomposites

Ahmed, A. and Narayanan, R.A.

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Fungal Biofilms as Low-modulus Structural Biocomposites

R A. Narayanan[1] and Ahmed, A.[2]
[1]Department of Physics, Birla Institute of Technology and Science Pilani, Hyderabad campus, Hyderabad, India.
[2] Section of Natural and Applied Sciences, Canterbury Christ Church University, Canterbury, United Kingdom.

INTRODUCTION

Biofilms

- Are formed by microorganisms that collectively organise at interfaces.
- Are self-assembling complex fluids consisting of rigid microbial cells embedded in a self-secreted soft biopolymeric extracellular matrix. (ECM).
- Possess an intricate porous network that holds nearly 90% by weight of water.
- Have been commonly studied for their ability to spread infection and corrode industrial equipment.

Biomaterials produced by microorganisms

- Such as bacterial cellulose, and more recently fungal mycelium-based biocomposites, typically require downstream processing to improve their mechanical strength.

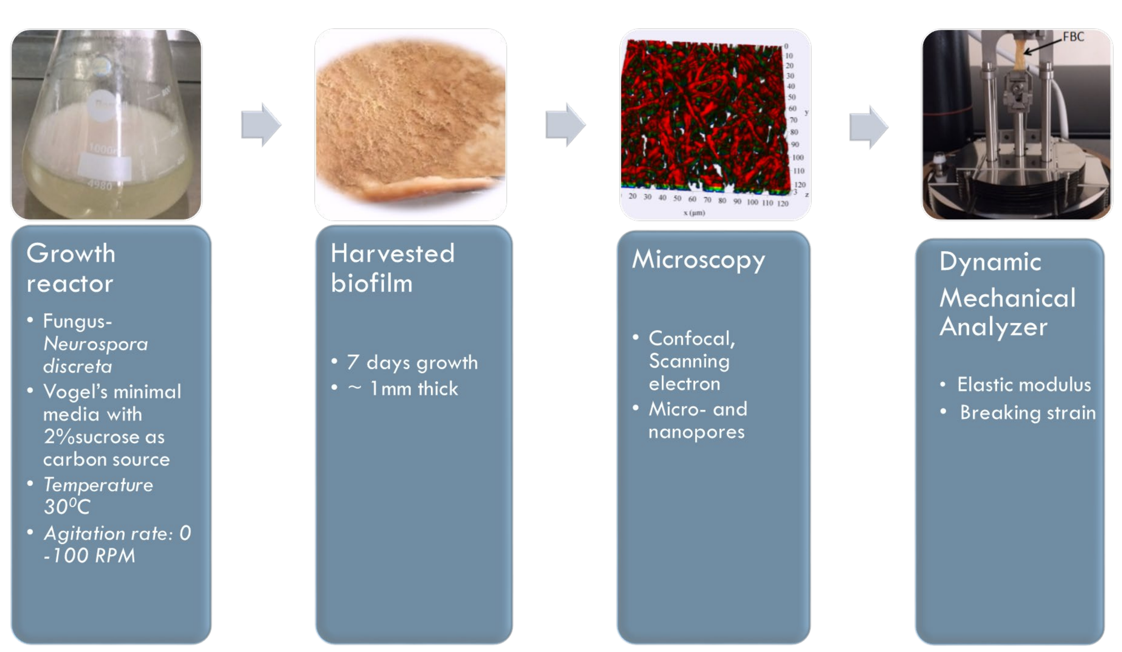
Research questions

- Can non-pathogenic biofilms find applications as useful biomaterials?
- Can biofilms be grown as biocomposites, thereby circumventing the need for downstream processing?

AIM

- To explore the biofilms formed by non-pathogenic fungus *Neurospora discreta* as low modulus structural biocomposites.
- To tune the microstructure and thereby the mechanical properties of biofilms which we have termed 'fungal biocomposites' (FBCs), by controlled agitation of the biofilm growth reactor, which imparts shear forces.

METHOD



RESULTS

Fig. 1 Biofilm formed by *N. discreta* on the air-liquid interface (*left*). Harvested biofilms grown under agitated (*top right*) and static (*bottom right*) conditions.

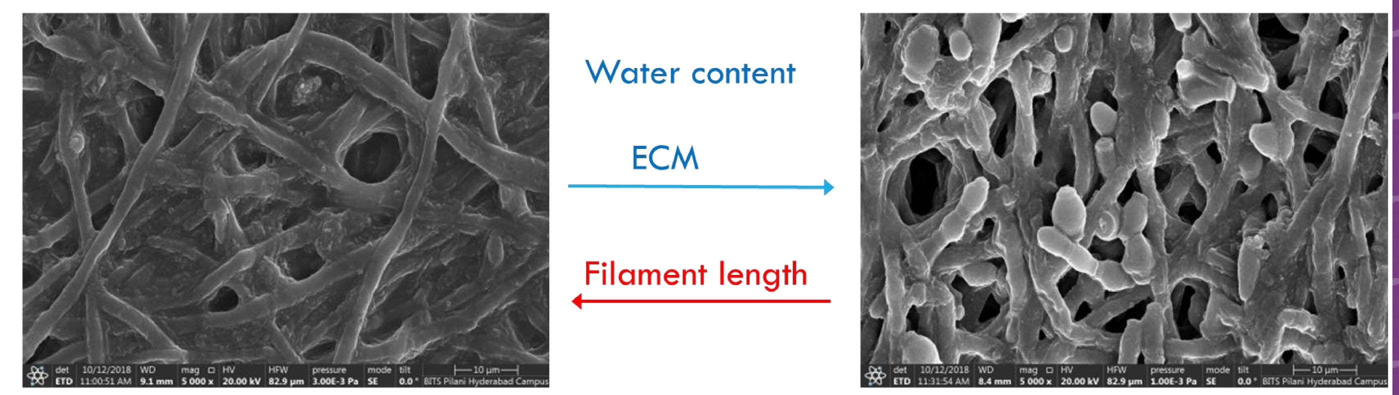


Fig. 2 Field emission micrograph shows the difference in microstructure between the static (*left*) and the agitated (*right*) FBCs. Water is held in micro-pores (visible voids) and nano-pores. Greater presence of ECM is seen in agitated FBCs – thickened region at the end of and around the filaments.

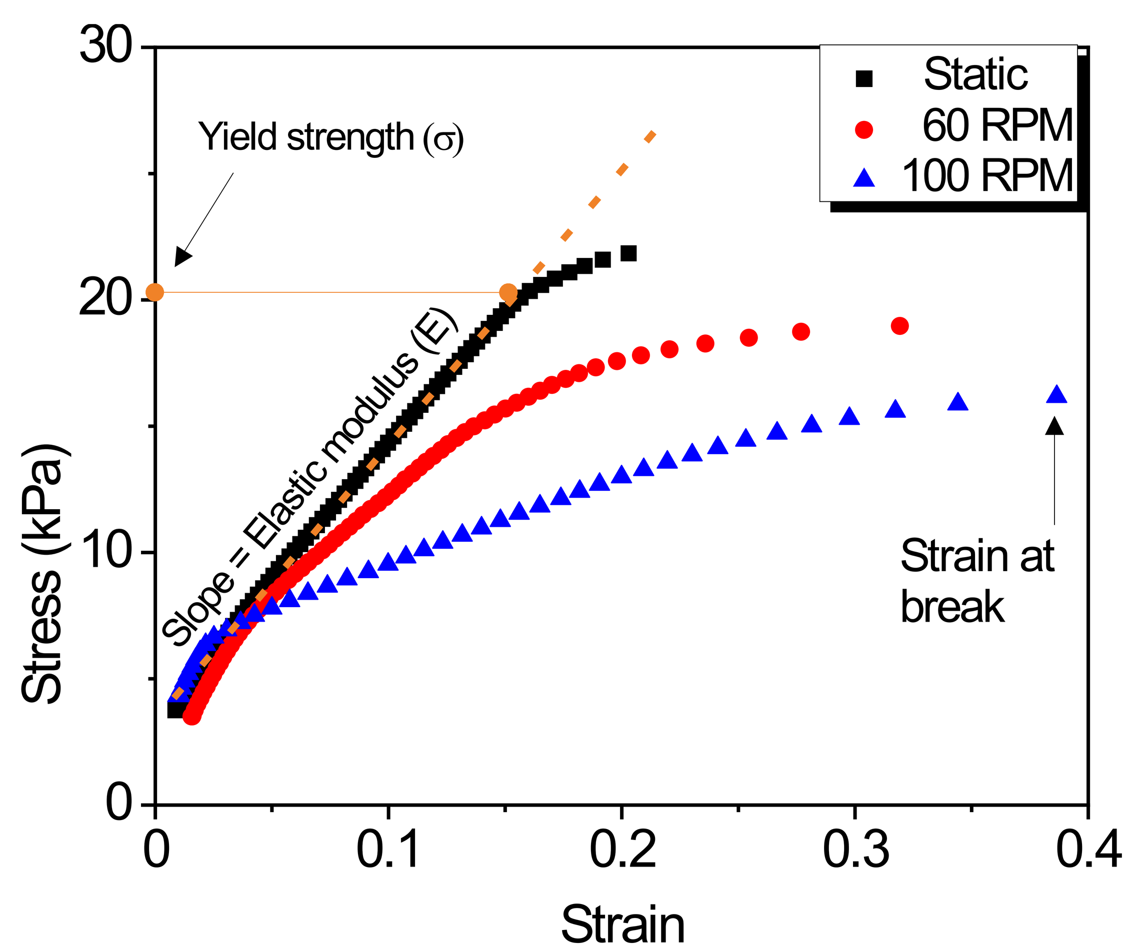


Fig. 3 Stress-strain curves for the FBCs grown under static and agitated conditions yielding easily with increasing agitation rate.

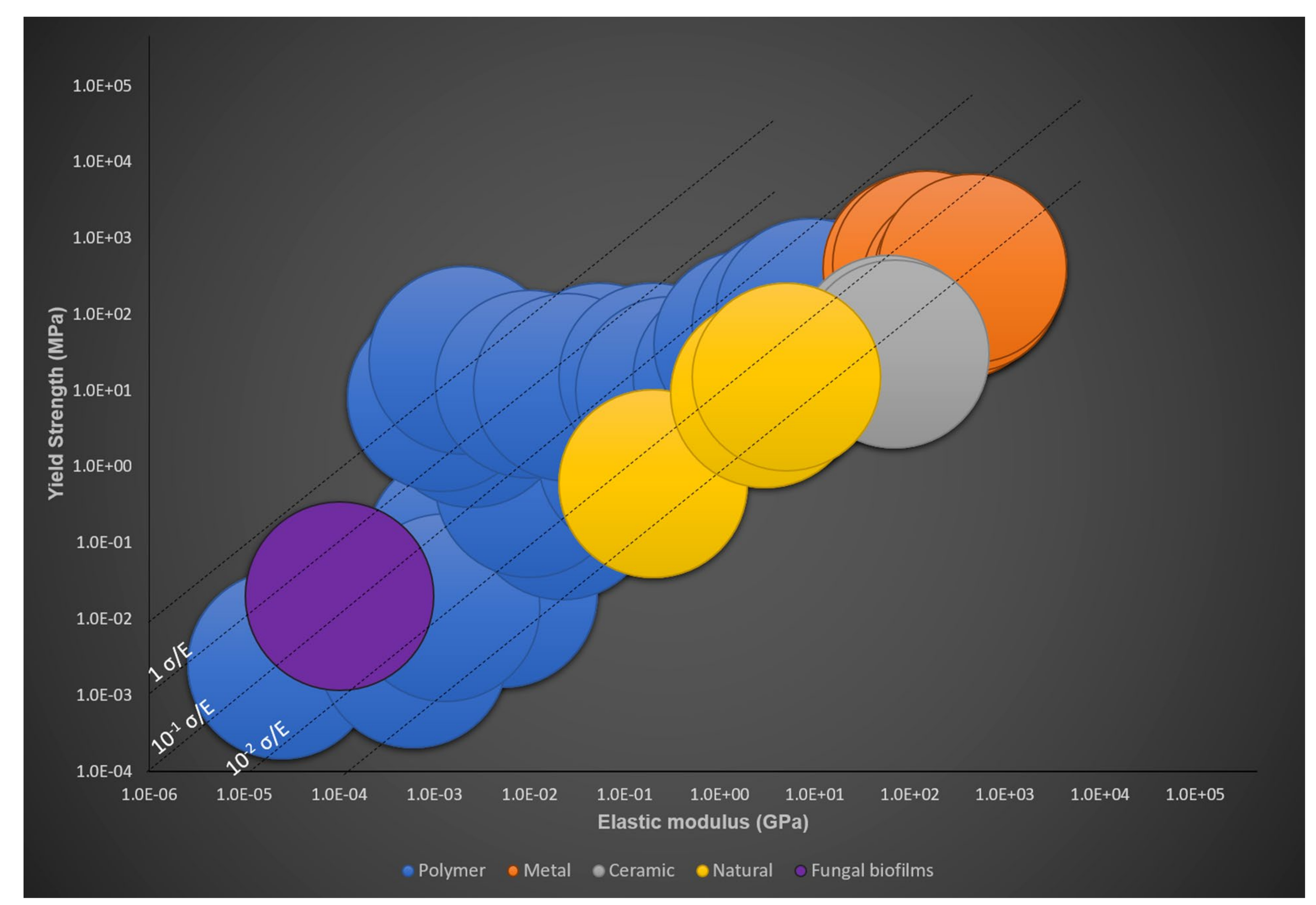


Fig. 4 In this Ashby plot, the material resilience parameter (σ/E) of FBCs lie in the same contour as ionomers and foams. Material resilience is the ability to bend without damage. The water held in the pores of the ECM acts as a plasticizer to control the ductility of biofilms.

CONCLUSIONS

We regulated the growth of fungal biofilms through controlled agitation of the growth reactor, to tune the microstructure and consequently the mechanical properties of biofilms, bypassing the processing stage.

These biofilms are fungal biocomposites with an elastic modulus of about 100 kPa and possess a material resilience similar to that of ionomers and foams.

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CONTACT INFORMATION

Prof. Aravinda N Raghavan
Department of Physics
Birla Institute of Technology and Science Pilani, Hyderabad campus, Hyderabad, India
Email: raghavan@hyderabad.bits-pilani.ac.in

Dr. Asma Ahmed
Section of Natural and Applied Sciences
Canterbury Christ Church University
N Holmes Road
Canterbury CT1 1QU United Kingdom
Email: asma.ahmed@canterbury.ac.uk