

Biomimetic PEEK Surfaces For Cartilage Preserving Focal Resurfacing

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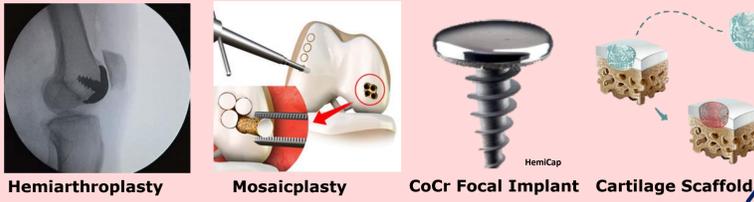


BRAGG CENTRE

1. Introduction

Functional cartilage lesion repairs are required to reduce incidence of TJR in younger patients

By 2030 it is predicted up to half of total joint replacement (TJR) recipients will be aged 65 or under, and for many in this age group the implants will fail in their lifetime, requiring costly revision surgeries with poorer prognosis¹.



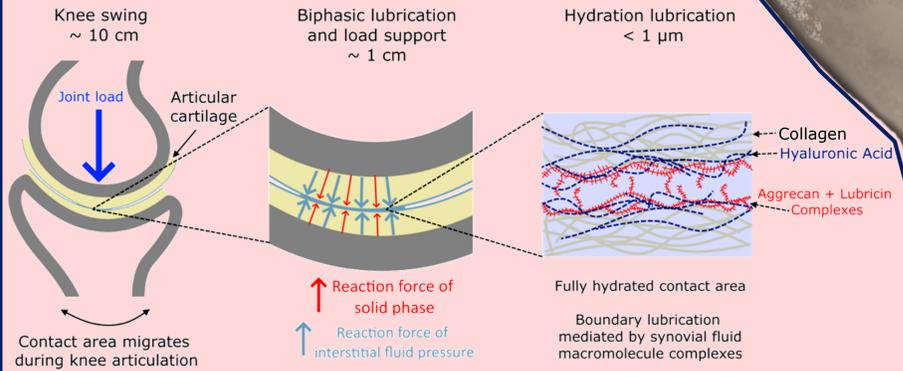
	Hemiarthroplasty	Mosaicplasty	CoCr Focal Implant	Scaffold
Immediately load bearing	✓	✗	✓	✗
Moduli matched for interfacing cartilage	✗	?	✗	?
Restore natural joint function	✗	✗	✗	?

Earlier interventions for young patients facing TJR:

- Repair focal defects and preserve healthy tissue
- Support natural cartilage function
- Fill treatment gap for patients unsuitable for biologics

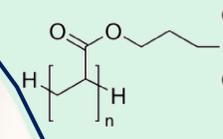
2. Synovial Lubrication: Biphasic & Hydrated

Through *biphasic lubrication* upwards of 90% of joint loads can be sustained by interstitial fluid pressure. Highly efficient *hydration lubrication* is enabled through macromolecular complexes formed by synovial fluid.



3. Biomimetic PEEK synthesis

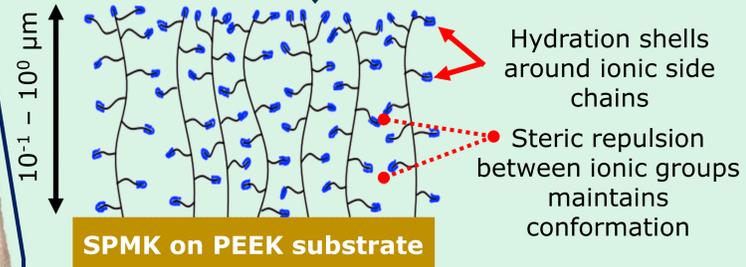
Biocompatible SPMK monomer



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SPMK + H₂O
Polished PEEK

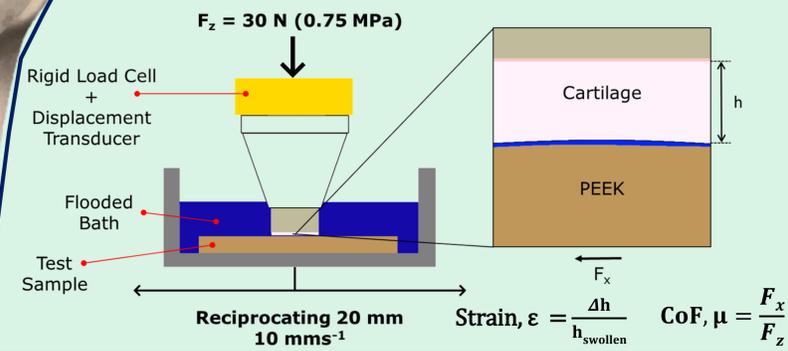
SPMK grafting via photopolymerisation



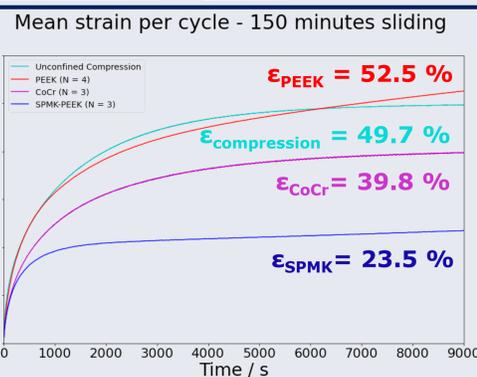
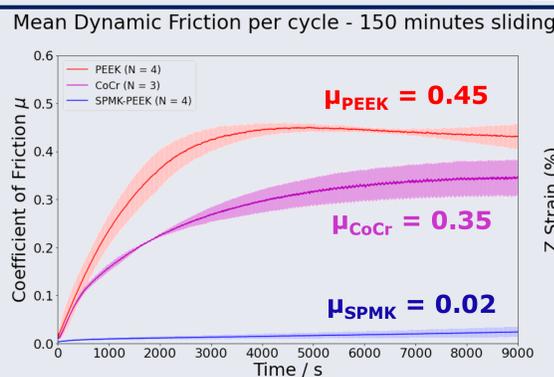
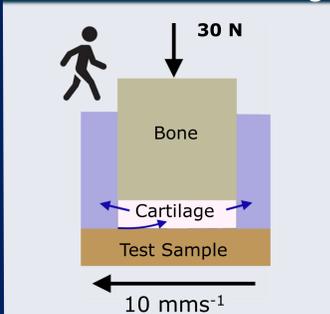
Hydrophilic polymers (SPMK) are grafted to PEEK to form a hydrated gel-type surface.
 ✓ Highly **hydrated**
 ✓ **Low elastic modulus** (~ 10¹ kPA) and can support joint loads (10¹+ MPA)

4. Testing methodology against bovine cartilage

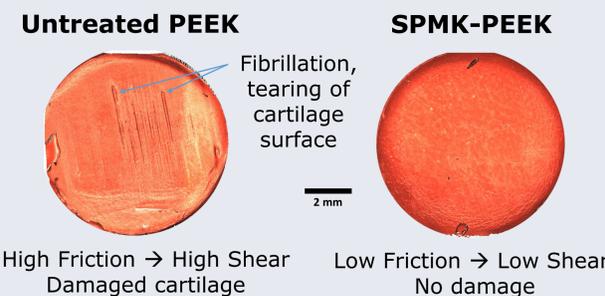
Cartilage pin-on-plate sliding whilst measuring friction and strain determine cartilage response against: **Unfunctionalised PEEK, SPMK-PEEK, and CoCr** (biomedical control).



5. Continuous Sliding

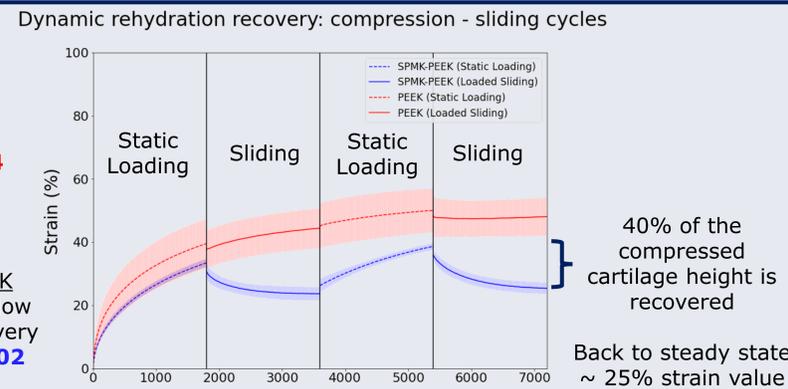
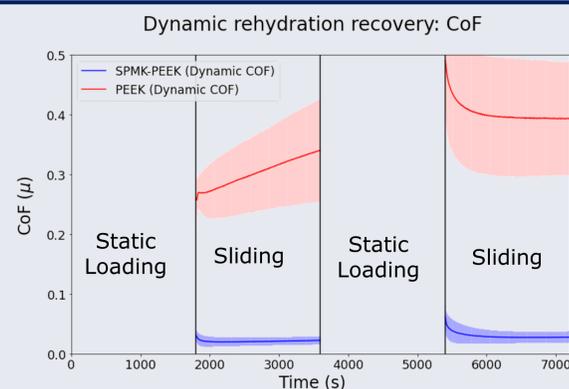
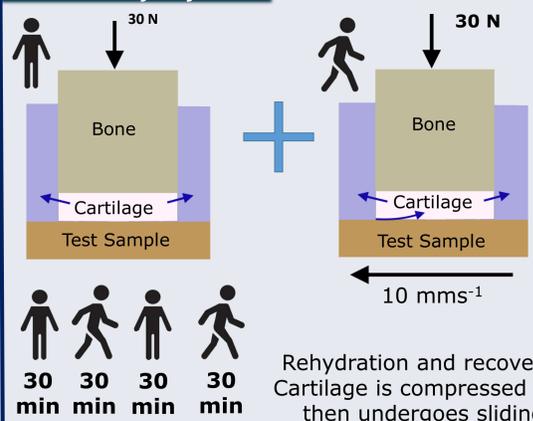


Cartilage surface analysis post testing:



Cartilage reciprocates at 10 mm s⁻¹ against test sample for 150 minutes → SPMK-PEEK exhibits sustained low friction enabled by **highly hydrated interface** → Low equilibrium strain for SPMK-PEEK, maximising **interstitial fluid maintained** → No damage on cartilage sliding against SPMK-PEEK sample: **effective interface tribology**

6. Activity Cycle



Rehydration and recovery: Cartilage is compressed and then undergoes sliding → SPMK-PEEK immediately recovers highly hydrated interface at onset of sliding to sustain low friction → At onset of sliding SPMK-PEEK is also able to support **rehydration of interfacing cartilage** to maintain interstitial fluid

7. Conclusion and medical device translation

SPMK-PEEK is a promising enabling technology to support natural joint function and preserve healthy cartilage

- Sustains a highly lubricious interface, reducing shear forces on cartilage
- Supports natural cartilage biphasic fluid load support
 - Exhibits lowest cartilage equilibrium strain (greatest interstitial fluid fraction)
 - Able to induce cartilage rehydration following sedentary period
- Minimises damage to interfacing cartilage

Enabling Technology: SPMK-PEEK interfaces to support healthy cartilage function

TRL 1 - 2

Optimisation of SPMK chemistry and mechanical properties using AFM and tribometer

Develop implant geometry using 3D printing for patient specific chondral defects

TRL 3 - 4

1. Bayliss, Lee E., et al. "The effect of patient age at intervention on risk of implant revision after total replacement of the hip or knee: a population-based cohort study." The Lancet 389.10077 (2017): 1424-1430

2. Knee Photo Credit: Adapted from Artcast Medical