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Editorial: Macromolecular Materials in the UK

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1 | Introduction

The United Kingdom continues to play a leading role in macromolecular materials science and engineering, where deep-rooted expertise in polymer chemistry, manufacturing, and biomedical engineering converge with urgent global needs. With increasing demand for sustainable, biocompatible, multifunctional, and digitally engineered polymeric systems, UK researchers are advancing both the theoretical foundations and applied innovations of macromolecular materials. This special collection of *Macromolecular Materials and Engineering*, titled "Macromolecular Materials in the UK," brings together 19 rigorously peer-reviewed research articles and reviews authored by teams across the UK and their international collaboration partners. Each contribution represents major advances in synthesis, characterization, functionalization, and application of polymer-based materials.

2 | Bio-Based Polymers and Sustainable Composites

Several contributions demonstrate the UK's focus on bio-based, degradable, and circular materials. **Rehman** et al. [mame.202400418] investigated the knife stab resistance of Bombyx mori silk cocoons, comparing entire cocoons (EC) with cocoon wall segments (CWS) through static and dynamic testing. Findings showed that ECs dissipate 95% of the kinetic energy during penetration, exhibit anisotropic and auxetic behavior, and provide greater stab resistance with smaller damage footprints than CWS. **Lalegani Dezaki** et al. [mame.202400276] fabricated PLA-based composites with wheat and mussel bio-fillers, exhibiting flame retardancy and shape-memory effects for 3D/4D printing applications. **Kacem** et al. [mame.202500067] highlighted the effective use of sulfuric acid and sodium hydroxide treatments to significantly enhance the tensile, compressive, and bending properties of yucca fibres and their epoxy-based bio-composites. Treated fibres showed improved surface morphology, crystallinity, and interfacial bonding. **Bakhtiari** et al. [mame.202500108] highlighted how processing sequence and compatibilization with Joncryl significantly influence the performance of PLA/PBAT blends. A two-step blending method improved interfacial adhesion, mechanical strength, and flexibility, offering promising applications in biodegradable packaging and films. **Harley** et al. [mame.202500129] reported the development of PA36,10, a novel biobased and recyclable thermoplastic elastomer synthesized from Priamine 1075 and sebacic acid without harmful solvents. Exhibiting excellent elasticity (1636% elongation at break), mechanical robustness, and foamability using a common blowing agent, PA36,10 offers a promising sustainable alternative for applications traditionally dominated by fossil fuel-based elastomers. **Krumins** et al. [mame.202500176] introduced monoperillyl maleate (PeryMal), a novel terpene-derived, photocurable monomer synthesized using green chemistry principles for sustainable stereolithography 3D printing. Blended with ACMO or bio-based iBoMA, PeryMal-based formulations exhibited excellent printability, tunable degradation, and thermal stability, marking a significant advancement in developing greener, functional resins with customisable properties.

3 | Forming with Soft Biomaterials

Electrospinning continues to be a dominant technique for generating functional fibres for drug delivery, sensors, and tissue repair. However, it is refreshing to see new mass production methods like pressure spinning (pressurized gyration) offer alternatives. **Yang** et al. [mame.202400286] engineered carbon-fibre-reinforced polyetheretherketone (CF/PEEK) composites for 3D printing and coated them with elastic nanofibres by electrospinning.

The composites showed improved hydrophilic properties for bone implants. **Anderson** et al. [mame.202400400] introduced a modified electrospinning setup to enhance the encapsulation of ferritin-like iron nanoparticles within Eudragit L100 polymeric nanofibres. This approach significantly reduced burst iron release, improving stability in gastric conditions and potentially enhancing bioavailability. **Thukral** et al. [mame.202400403] explored the development of artificial saliva-loaded core-sheath fibres using the pressurized gyration technique. Their work represented the first effort to integrate artificial saliva into fibre manufacturing, providing a biocompatible, non-toxic, and degradable wound dressing material with enhanced antibacterial efficacy. **Shafi** et al. [mame.202500023] developed and evaluated electrospun cellulose-based fibres loaded with progesterone (PGS) for transdermal hormone delivery in menopause therapy. The addition of surfactant enhanced PGS diffusion, and in vitro testing confirmed the system's potential as a minimally invasive, personalized alternative to traditional hormone replacement methods. **Grano de Oro Fernandez** et al. [mame.202500031] presented the fabrication of electroconductive polymeric fibres using pressurized gyration, combining PPy/PCL and PEDOT:PSS/PEO to mimic natural cardiac tissue structures. The scaffolds demonstrated physiologically relevant electrical conductivity and fibre morphology, validating their potential for cardiac tissue engineering and myocardial infarction treatment. **Asare** et al. [mame.202500074] developed electrospun nanofibres by blending bacterial cellulose (BC) with short- and medium-chain polyhydroxyalkanoates (PHAs), producing bead-free fibres with tuneable diameters and surface roughness. The BC/PHA composites demonstrated enhanced thermal stability and supported improved neurite outgrowth and cell viability, showing strong potential for nerve tissue engineering and broader biomedical applications. **Rezaeinia** et al. [mame.202500079] reviewed the application of electrospinning to plant-based proteins, emphasizing strategies to overcome their intrinsic structural limitations, such as low solubility and entanglement, for nanofibre formation. Their review highlighted promising innovations in processing techniques, reinforcing electrospinning's potential in sustainable food, biomedical, and packaging applications. **Wall** et al. [mame.202500091] presented a novel phosgene-free method for synthesizing poly(amino acids) using bio-derived 2,5-diketopiperazines, offering a safer and sustainable alternative for biomedical applications. Amphiphilic block copolymers formed stable, pH-sensitive nanoparticles capable of controlled doxorubicin release, demonstrating promise for stimuli-responsive drug delivery systems. **Chung** et al. [mame.202500119] introduced a solvent-cast direct-writing technique to fabricate PCL/PLA scaffolds capable of sustained, tunable ibuprofen release without heat or harsh conditions, making it ideal for thermosensitive agents. It demonstrated the potential of a low-temperature 3D printing method for personalized drug delivery and tissue engineering platforms. **Qian** et al. [mame.202400356] provided an overview of polymers proposed as in situ gelling formulations for nasal delivery. They reviewed characterization methods, highlighting the lack of standardization and accepted target values, and then discussed applications by spraying.

4 | Advanced Characterization, Modeling, and Manufacturing

Zahedi et al. [mame.202500073] introduced a deep learning approach using convolutional neural networks to accurately predict mechanical properties such as volume fraction, Poisson's ratio, and elastic modulus of personalized bone scaffolds. Their model outperformed several transfer learning models, offering a faster and more precise tool for designing patient-specific implants and improving surgical outcomes. **Livi** et al. [mame.202500082] investigated water adhesion on electrospun hydrophobic fibres, demonstrating that contact angle hysteresis, not the receding angle alone, correlates most strongly with maximum normal adhesion forces. Fibres composed entirely of PCL exhibited the highest adhesion, and they proposed micromechanical tensiometry as a more robust and accessible method than goniometry for characterizing fibrous hydrophobic surfaces. **Weygant** et al. [mame.202500189] introduced a novel 3D freeze-printing technique to fabricate high-conductivity Poly(3,4-ethylenedioxythiophene) polystyrene sulfonate structures with superior structural fidelity and minimal processing requirements. By enabling direct printing on soft substrates like alginate hydrogels, the method significantly enhanced conductivity and interface performance, positioning it as a valuable advancement for wearable and implantable bioelectronic applications.

5 | Conclusions

This special issue reflects the UK's strategic and scientific priorities in sustainable polymer design, electrospun and pressurespun biomaterials, biodegradable composites, and advanced manufacturing methods. One vital emerging factor is scale up and sustainability, including energy consumption. The included works demonstrate a strong alignment between fundamental science and application-driven engineering, with potential impacts in packaging, healthcare, electronics, and environmental stewardship. We express our sincere gratitude to the contributing authors and reviewers, and we thank the editorial team, especially Dr. David Huesmann at *Macromolecular Materials and Engineering*, for enabling this special collection.

As the field continues to evolve, we anticipate that future UK-led efforts will further integrate machine learning, digital fabrication, and circular materials design, vastly expanding the frontiers of macromolecular engineering.

Conflicts of Interest

The authors declare no conflict of interest.