A BEM-BASED MODEL FOR WEAR IN THE CONTACT OF TEXTILE FIBRES

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ABSTRACT
A recent report from the European Environment Agency [1] highlights that over 14 million tonnes of microplastics have been polluting the ocean floor, with this amount steadily increasing annually. Understanding how fibrous microplastics form is crucial for reducing their release from textiles. To simulate the wear of textile fibres, the boundary element method (BEM) is used due to its efficiency and accuracy in solving contact problems at the microscale.

Inspired by the models of Li, et al. [2] and Akchurin, et al. [3], rather than applying an empirical law (e.g., Archard's wear equation), the von Mises stress criterion is used to determine the generation of wear particles in our work. This criterion states that wear occurs when the von Mises stress exceeds the yield stress of material within a specific volume of the object exposed to the surface. Instead of removing all identified wear particles immediately from the component [2,3], a threshold value is assigned to the removed surface layer each time updating the surface profile. The pressure distribution and von Mises stress are then recalculated until the identified wear volume for the body with the latest surface vanishes.

Using Fast Fourier Transform (FFT)-based approaches [4], various contact configurations in the contact of textile fibres (e.g., three-dimensional point (elliptical) and line contact) can be efficiently simulated. Here, the case of a rough sphere undergoing frictional sliding is given as an example result. The initial rough sphere surface is depicted in Fig 1. a, which exhibits irregularities and asperities. The effects of wear tend to smoothen out the surface irregularities, leading to a smoother surface texture shown in Fig 1. b.

Alongside the computational modelling of contact configurations of textile fibres, experimental research is underway to determine the crucial properties of the textile fibres, such as elastic modulus, relaxation modulus (if treated as linear viscoelastic material) and coefficient of friction, using various experimental techniques. For example, the coefficient of friction was tested with the nanotribometer shown in Fig. 2. Efforts are also focused on acquiring the surface topography data of the fibres. They will soon be input into the model to help the minimization of the wear particles released by textile fibres.

Fig 1.a

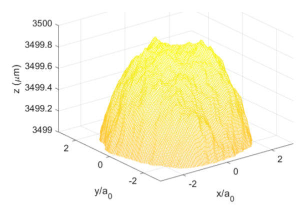


Fig 1.b

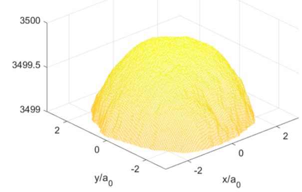
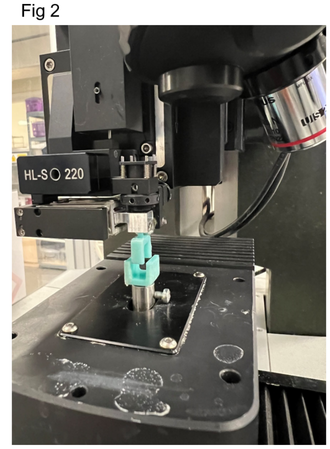


Fig 2



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