Nanoscale tribology of hair fibres over large displacements

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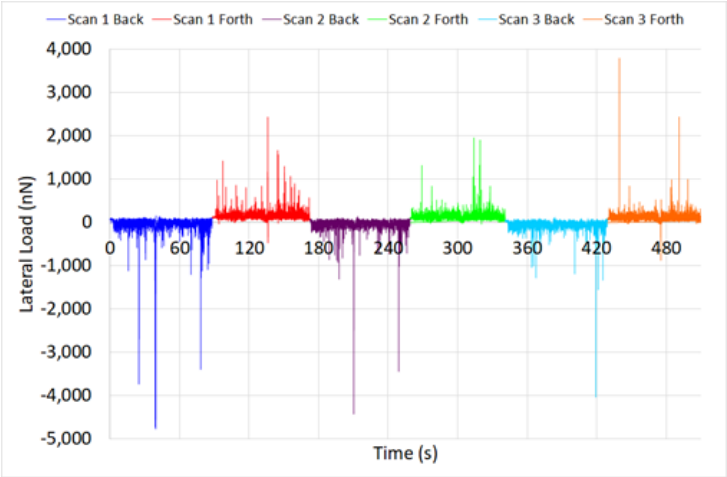
Background incl. aims
Hair is a protein-based, filament-like biomaterial that grows from follicles beneath the surface of the skin. The evolution, structure and function of human hair is of great interest to anatomists and anthropologists, and the use of hair for social and cultural functions is well established. There have been many scientific studies regarding hair structure, the physicochemical properties of the hair cuticle surface, and hair damage mechanisms. Atomic force microscopy has played a crucial role for studies of friction and conditioners applied to single hair fibres.

Methods
This work reports the development of a method for measuring the tribological properties of two orthogonally crossed cylinders over a 2 mm displacement with nanoscale precision in loads and displacement. Specifically, a human hair fibre was used as the lower cylinder, while the upper cylinder was a 0.5 mm section of 75 µm diameter tungsten wire. Measurements were performed at a sliding velocity of 20 µm/s, the compressive normal load between the cylinders was 600 nN, and data were recorded every 2 nm.

Results
Topography and lateral load were recorded throughout the bidirectional measurement, with differential friction observed upon comparison of the 'with cuticle' and 'against cuticle' sliding directions (Fig. 1). To assess the influence of sliding velocity on the frictional behaviour a sequence of increasing velocities in the range 0.01-1.0 mm/s was programmed; the total displacement of this measurement covered 5 mm.

Conclusion
The mean friction coefficient did not vary significantly with sliding velocity, although occasional high lateral loads were observed at velocities in excess of 0.1 mm/s.

Graphic:



Keywords:

fibre, friction, hair, load, tribology