46th Leeds-Lyon Symposium on Tribology - September 2-4, 2019, Lyon, France

FINGERTIP FRICTION AND TACTILE PERCEPTION OF SURFACE STRUCTURE

R. Sahli[a], A. Gedsun[a], A. Prot[a], R. Hensel[a], A. Wang[b],
H. Kirchner[a], E. Arzt[a], M.H. Müser[b], R. Bennewitz[a,*]
*roland.bennewitz@leibniz-inm.de
[a] INM – Leibniz Institute for New Materials,
66123 Saarbrücken, Germany
[b] Department of Materials Science and Engineering, Saarland University,
66123 Saarbrücken, Germany

KEYWORDS

Friction; Everyday life tribology; Biotribology; Haptics

ABSTRACT

The haptic perception of materials is one of the key elements of everyday life in which friction plays an important role [1]. The structure of surfaces leads to a spatial and temporal modulation of friction forces and thus of strain in the skin which is sensed by our nervous system. Friction dynamics are of particular importance for the perception of structures which are small on the scale of finger ridges and of the characteristic distance between nerve endings. Here we report on experiments addressing the relation between fingertip friction and tactile perception for manufactured samples which have a well-defined surface microstructure.

For the first study, we have manufactured elastomer samples with a fibrillar surface structure. Hexagonal arrays of fibrils with 400 µm diameter and a varying height where produced by replica molding of different elastomer materials [2]. We found that fingertip friction decreases with increasing elastic modulus of the material, but depends only weakly on the fibril height. Study participants were asked to rate the similarity between samples as perceived by tactile exploration. Differences in both the fibril height and the elastic modulus were perceived by the participants through sliding contact with the fingertip. Multidimensional scaling analysis allowed to construct a map of perceived tactile distances between the samples. One dimension of this map was found to correlate with the bending stiffness of the fibrils (see Fig. 1), which will be discussed as a feature in tactile perception.

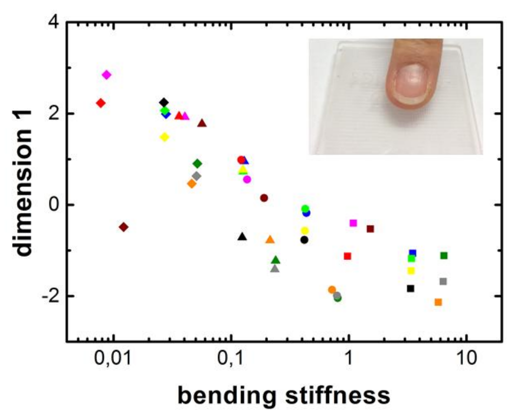

Fig.1: Results for an experiment on the tactile perception of micro-structured fibrillar surfaces, which were explored by sliding the fingertip over the surface. One perceptional dimension was found to correlate with the bending stiffness of the fibrils.

For the second study, randomly rough samples with a well-defined roughness spectrum were defined by a computer code [3] and produced by 3D printing. We will present first results for the relation between the roughness spectrum and fingertip friction, and discuss the role of roughness in the perception of similarity between the samples.

REFERENCES

[1] W.M.B. Tiest, Vision, 50 (2010) 2775-2782.
[2] R. Hensel, K. Moh, E. Arzt, Advanced Functional Materials, 28 (2018).
[3] M. Müser *et al.* Trib. Lett. 65 (2017) 118.