

Frictional behaviour of silicone structured surfaces simulating tongue roughness

H. Ranc¹, C. Servais¹, P.F. Chauvy², S. Debaud², S. Mischler²

¹Nestlé Research Center, Vers-Chez-Les-Blanc, CH-1026 Lausanne, Switzerland

²EPFL, Laboratoire de Métallurgie Chimique, Lausanne, Switzerland

INTRODUCTION: Food when eaten is squeezed and sheared between the tongue and other oral surfaces. Tribological properties of interacting surfaces in relative motion can be used to explain some physico-chemical phenomena that govern oral perception of food structure [1]. Although several tribology studies were performed between soft/hard surfaces to emulate more realistically the forces applied in the mouth [2-3], the influence of the rough nature of the tongue surface was not addressed. Indeed, the human tongue has a rough surface with a large density of papillae in the sub millimetre range.

The objective of the present study is to assess the influence of surface structure on friction coefficient of a model tribosystem representing the tongue/palate contact under dry conditions and in the presence of oil and aqueous solution having the same viscosity at 36°C.

METHODS: Soft silicone samples with well-defined surface structures, based on hemispherical pillars of different dimensions (Table 1 and Figure 1) were fabricated by a moulding technique to simulate tongue roughness. The friction experiments were performed on a reciprocating motion sliding tribometer involving contact between a relatively hard ball representing the palate and one of the soft silicone surfaces simulating the tongue. Tests conditions (0.31 MPa, 10 mm s⁻¹ and 36°C) were designed to represent those encountered in the mouth when thin films of food residues coat the oral mucosa surfaces.

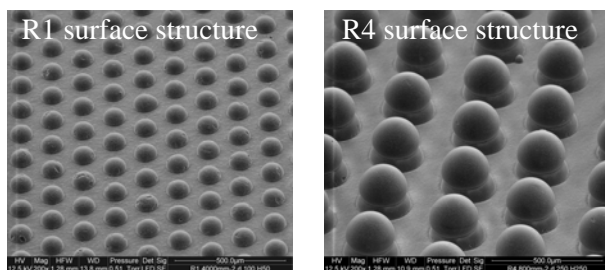


Fig. 1 SEM images of silicone surface structures R1 and R4 with hemispherical pillars.

RESULTS & DISCUSSION:

The frictional behaviour of the investigated tribosystem is strongly affected by the surface

structure of the contacting surfaces as pointed out in Figure 2 (where R0 denotes a flat specimen).

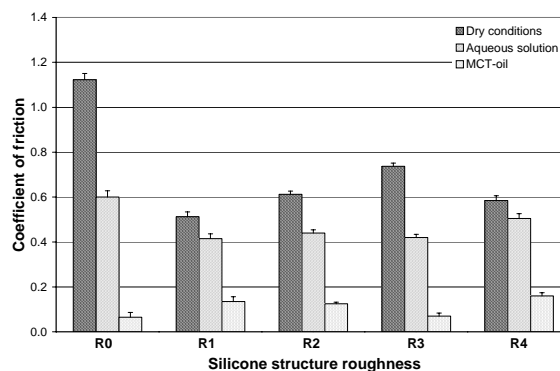


Fig. 2 Effect of the surface structure on the coefficient of friction under dry conditions and with aqueous or oil-based lubricant.

Under dry conditions, the coefficient of friction decreases significantly with increase of hemispherical pillar density. With aqueous solution or MCT-oil between the contact surfaces, these differences are relatively lower. For lubricated surfaces, higher pillars with an optimal high density increase the friction coefficient.

Table 1. Geometric parameters of silicone structured surfaces of different dimensions.

Silicone surfaces	Density mm ⁻²	Diameter μm	Height μm
R1	40	100	50
R2	8	250	125
R3	2.5	250	125
R4	8	250	250

CONCLUSIONS: The use of moulded silicone surfaces appears to be interesting to mimic tongue properties. This novel approach constitutes a promising way to assess the effect of tongue topography on “in-mouth” friction.

REFERENCES: ¹M.E Malone, I.A.M Appelqvist, I.T. Norton (2003) *Food hydrocolloids*, **17**: 763-773. ²J. de Vicente, J.R. Stokes, H.A. Spikes (2005) *Tribo. Int.* **38**: 515-526. ³G. Cassin, E. Heinrich, H.A. Spikes (2001) *Tribo Lett* **16**:239-249.