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Micro-Tribometer for the characterization of friction forces between contact lenses and model materials

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Introduction

The friction forces between contact lenses and the posterior surface of the eyelids have been shown to correlate to carrying comfort [1]. Nonetheless, there is currently no standard method for testing the tribologic properties of contact lenses [2,3]. In this work an experimental setup have been developed, which allows for continuous measurement of friction forces down to 0,1 mN. Preliminary measurements with hard contact lenses against a lubricated glass surface have been made.

Materials and Methods

The pin-on-disc method (Fig. 1) was used to measure the friction forces between the contact lenses and a rotating surface. The experimental setup is shown in Fig. 2. The contact lenses (RPG, Wöhlk GmbH, Germa-ny) were glued to a brass form on the tip of the sample holder. The curvature of the form was the same as that of the contact lenses to avoid excessive deformation of the lenses. The sample holder was attached through a cantilever to a custom-made torsion spring, fixed to a high precision force sensor (Leybold didactic, Force sensor S 524 060). The sensor can detect force changes as low as 0,01 mN (resolution). The Rota-ry stage is driven by a brushless DC servo Motor with integrated gear (2232 S024, Faulhaber GmbH, Germany) . Rotation speeds from 0,3 rpm to 30 rpm were possible. Normal loads between 10 mN and 50mN were used for the measurements.

The friction surfaces were lubricated using saline solution.

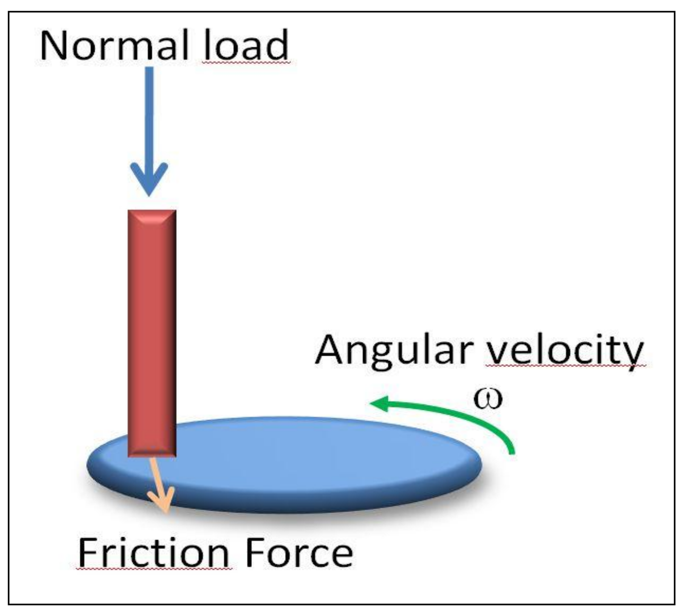

Figure 1 pin-on-disc method for measuring Friction

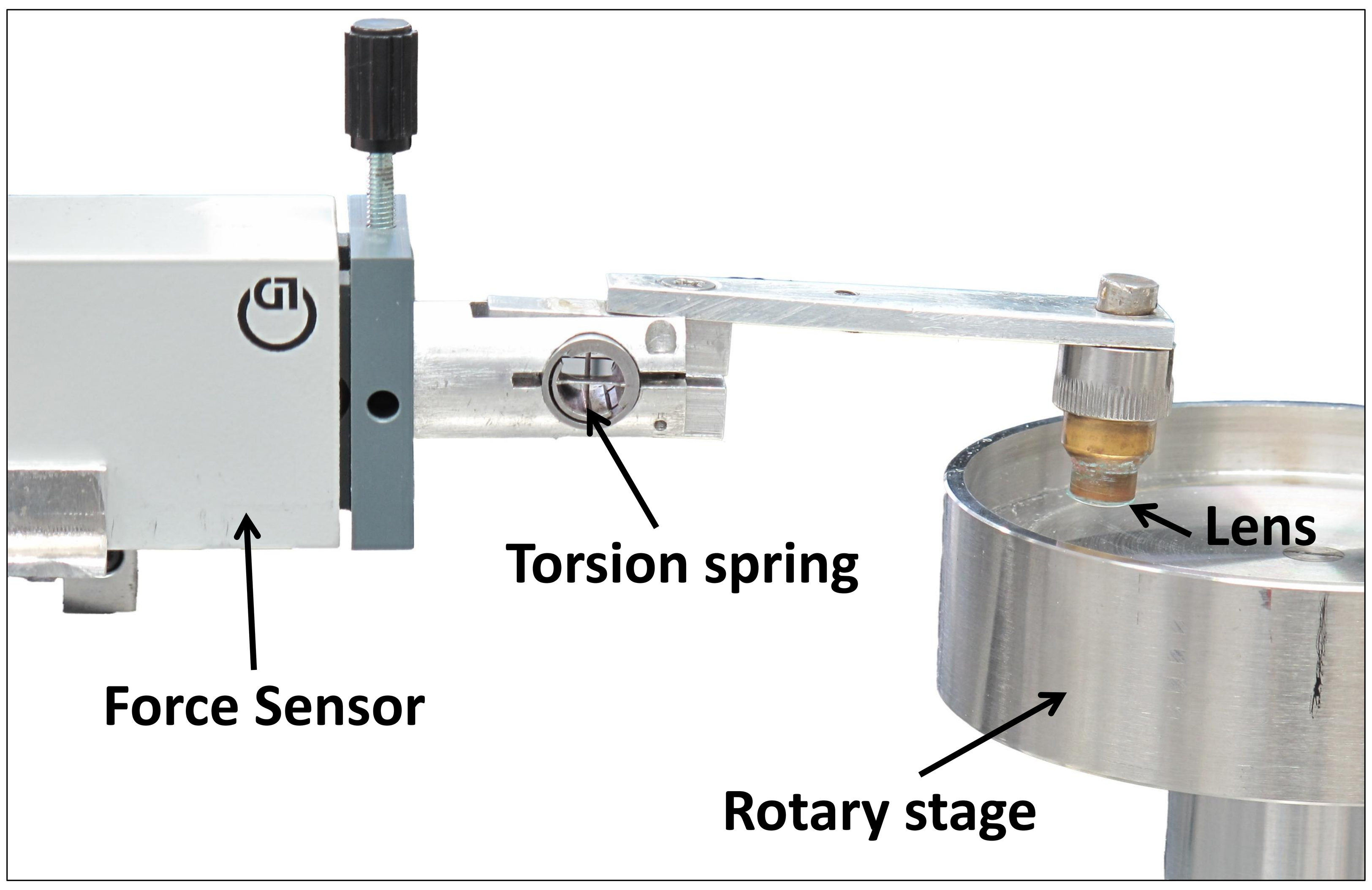

Figure 2 Experimental setup

Results and discussion

Fig. 3 shows the measured friction force as a function of time for a RGP contact lens at 5 rpm rotation speed and 10 mN normal load. An oscillation with the same period as the rotary motion of the stage can be seen. After ruling out effects like fluctuations of the normal force or of the rotation speed, the oscillation of the friction force was found to be caused by changes in the dynamic friction coefficient at different point of the glass surface.

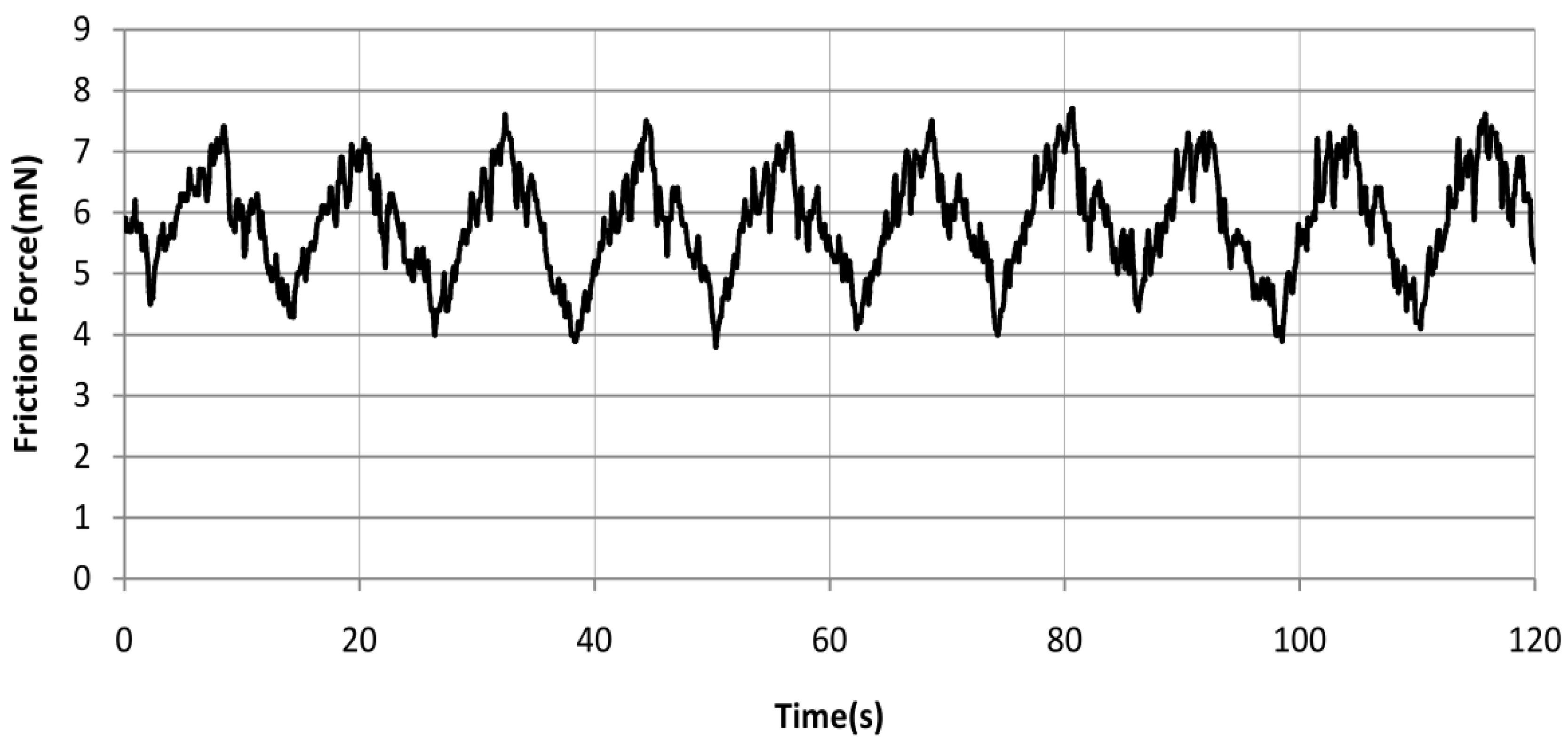

Figure 3 Frictios Force vs. time at 5 rpm and 10 mN normal Force

The dependency of the friction force with the applied normal load has been also analyzed for a constant rotation speed. The results are shown in figure 4. As opposed to what is observed between hard and dry materials, there is here no linear dependency between the normal load and the friction force. This means the that the actual dynamic friction coefficient depends on the applied normal load, even at this extremely low loads.

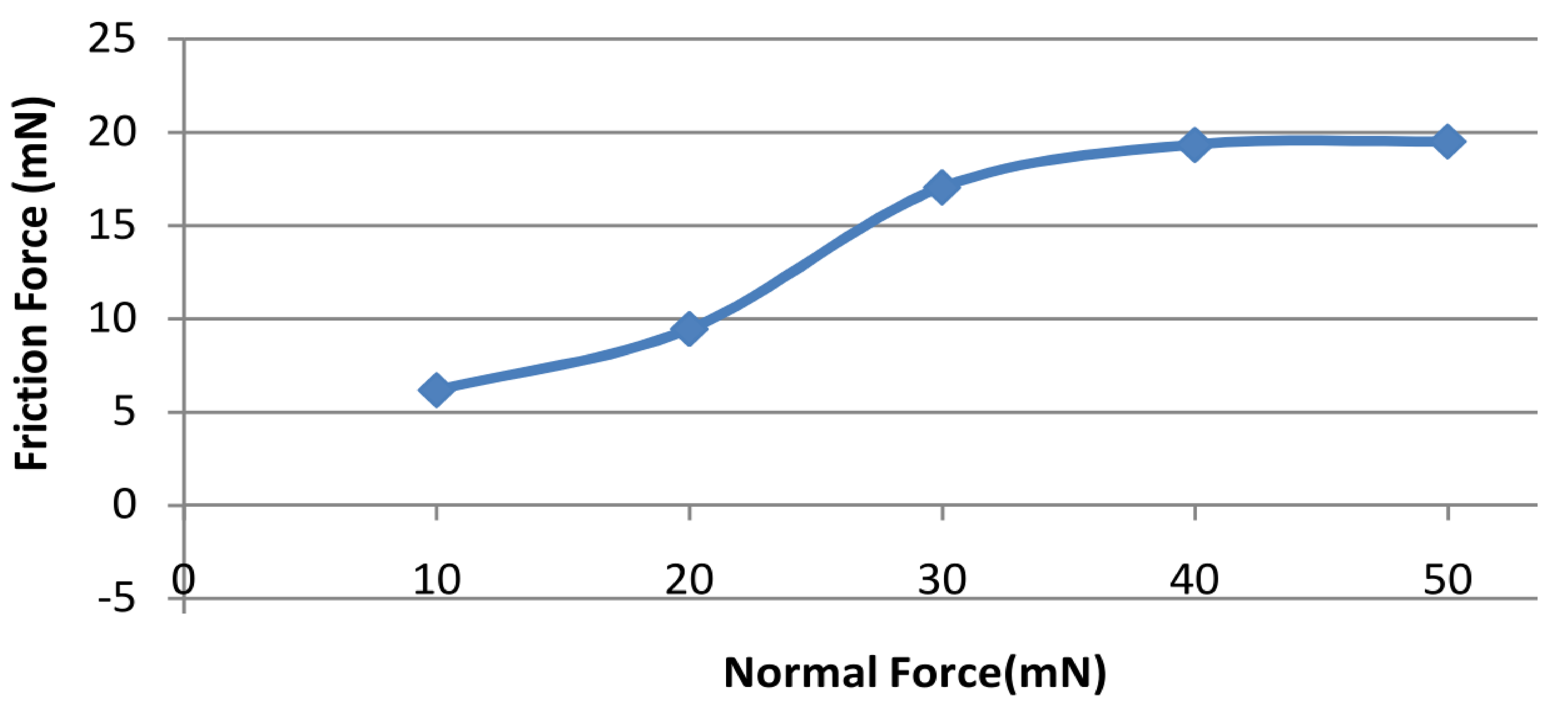

Figure 4 Effect of increasing normal force on the friction force at 2 rpm

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