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Research paper

A study of the frictional properties of senofilcon-A contact lenses

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ABSTRACT

The frictional property of soft contact lenses could have a great impact on their clinical performance. However, to date, only a handful of studies have been conducted to understand the friction mechanism(s) of the soft contact lens. In the current paper, the friction of senofilcon-A contact lenses has been studied with a stainless steel ball as the counterface in a saline solution. The load applied was between 0.5 mN and 100 mN and the sliding velocity ranges from 0.01 cm/s to 0.5 cm/s. It was found that the friction force is proportional to normal load as described by Amonton's law and this unexpected behavior can be attributed to the fact that viscous flow contributes little to the overall friction and that solid–solid contact dominates the friction of senofilcon-A. It was also found that the coefficient of the friction increases with the velocity and the quantitative relationship between them can be explained reasonably well with a previously proposed "repulsion–adsorption" model. The impacts of material chemistry, water content, test media, applied load and the sliding velocity on the friction mechanism(s) are also discussed.

1. Introduction

Since Wichterle and Lim proposed (Wichterle and Lim, 1960) that their new polymer, poly hydroxyethylmethacrylate (pHEMA), could be used to make contact lenses half a century ago, the polymer hydrogel-based soft contact lenses have been extensively utilized for vision correction (McMahon and Zadnik, 2000). Currently, in the United States, there are roughly 28 million soft contact lens wearers (McMahon and Zadnik, 2000). A polymer hydrogel is a crosslinked hydrophilic polymer network solvated with water and it behaves like both solid and liquid (Gong, 2006). Like a solid, the hydrogel deforms under applied stress and recovers after the stress is released. Like a liquid, the hydrogel supports diffusion of the solutes when the size of solutes is smaller than the mesh size of the network (Gong, 2006). During blinking, the eyelid is sliding against the surface of the eye. When a contact lens is placed on the eye, the surfaces of the contact lens change the frictional forces during blinking and thus change the "feel" of the blinking process (Nairn and Jiang, 1995). There is existing clinical hypothesis that different friction will result in different ocular comfort (Rennie et al., 2005). Indeed, although soft hydrogel contact lenses are well suited for the eye, a significant fraction of people are unable to wear contact lenses because of extensive eye irritation, which could be closely related to the friction (Rennie et al., 2005).

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