## Title
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# Brushed
# Soft Contact Lenses for Reducing Lid-Wiper Sliding Friction

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Minimal
sliding friction of soft contact lenses (SCLs) is critical to on-eye comfort.[1,2] In spite of significant attention in recent years, sufficient lens lubricity has not been achieved.[2] We investigate use of strongly-hydrophilic polyelectrolyte brushes to reduce sliding friction of SCL-hydrogel surfaces in the ?high? friction boundary lubrication regime that is most likely the origin of wear discomfort. Anionic
poly(acrylic acid) (PAA,
435 kDa)
strands are physically entrapped in HEMA-based SCLs. Briefly, aqueous-equilibrated SCLs were swollen in isopropanol (IPA), containing dissolved PAA. Subsequently, PAA-containing SCLs were deswollen (i.e., solvent
exchanged) in aqueous phosphate-buffed saline (PBS, pH 7.4) to physically entrap the polymer. Successful
brush attachment is confirmed by comparing surface forces measured by colloidal-probe atomic force microscopy (AFM) on a SCL hydrogel before and after brush treatment, and by fluorescence confocal laser-scanning microscopy
(FCLSM) of fluorescently-labeled polymers. By way of example, Figure 1 displays
a typical FCLSM image of an aqueous-equilibrated HEMA-based hydrogel immediately following anionic FITC-labeled PAA brush attachment. Fluorescence-intensity
profiles clearly confirm successful polymer entrapment, with no observable FITC-PAA leaching even after 2 wks.
Aqueous
sliding friction forces are obtained using both colloidal-probe
AFM and the inclined-plane method (IPM). Figure
2 shows
typical
aqueous

sliding friction coefficients, CoFs, for a HEMA-based SCL and a PAA-brushed HEMA-based SCL obtained from both AFM and the IPM. Several features are salient. COF values are reduced significantly for the PAA-brushed HEMA-based
SCL compared to the unbrushed SCL. The CoF value for the HEMA-based SCL is 0.06
from both colloidal-probe AFM and the IPM, in in good agreement with literature
values.[3] For the PAA-brushed HEMA-based SCL, however, the CoF value measured by colloidal-probe AFM is nearly an order of magnitude lower than that
obtained from the IPM (i.e., 0.004 compared to 0.02). This
finding indicates that the IPM is unsuitable for obtaining low CoF values (i.e., lower than 0.02). Our colloidal-probe AFM measurements reveal that entrapped anionic PAA brushes in conventional HEMA-based SCL hydrogels reduce
lens sliding friction in the ?high? friction boundary lubrication regime by over an order of magnitude.

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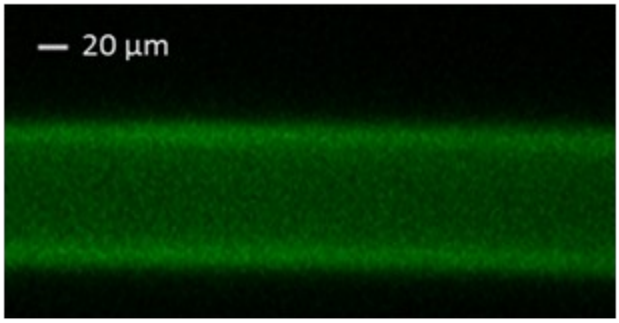


**Figure 1.** A typical fluorescence-confocal-microscopy image of an aqueous-equilibrated HEMA-based hydrogel immediately following anionic FITC-PAA brush entrapment. Scale bars represent 20 µm in the vertical direction.

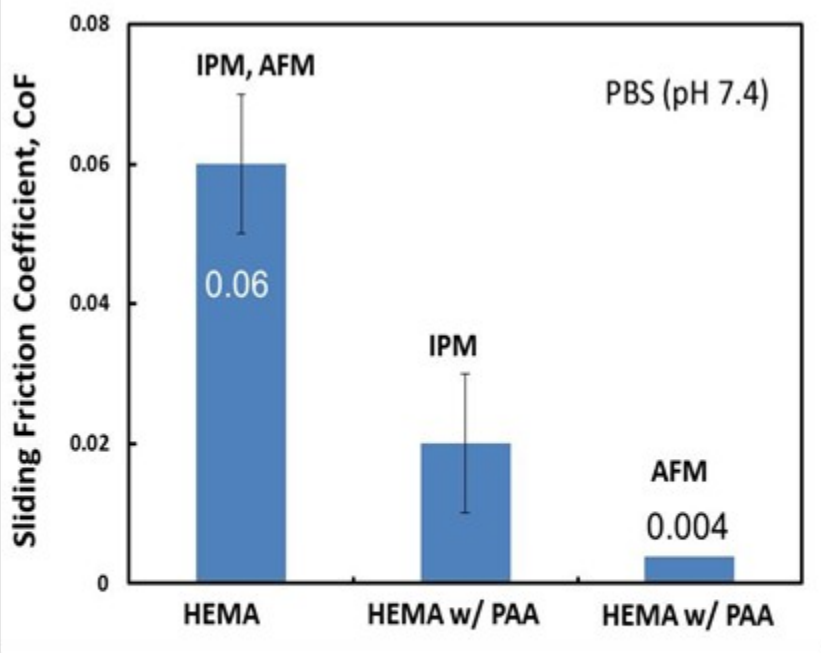


**Figure 2.** Aqueous sliding friction coefficients, CoFs, for a HEMA-based SCL and a PAA-brushed HEMA-based SCL obtained from both colloidal-probe AFM and the IPM.