Nondestructive Evaluation of the Thermoelastic Properties of Contact Lenses by Photothermal Deflection Technique

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Mechanical characteristics of soft contact lens material are critical in design, quality control processes, properties and comfort. Most soft contact lenses are made of hydrogels. Mechanical properties such as elastic modulus, stiffness, flexural rigidity and viscoelasticity thus have major impact on the ability to maintain the physical geometry and dimension, on the capability to return to the original shape at removal of external load, on the adhesion to the cornea, and swelling behavior and proliferation of cells. Moreover soft contact lenses are commonly used to correct refractive errors of the eye and protect the ocular surface from ocular damage and after corneal surgery. Monitoring the intraocular pressure is an essential part of daily clinic activity, and tonometry through the soft contact lenses is convenient especially when treating subjects with ocular surface diseases. The effects of conventional soft contact lenses of low power on the intraocular pressure have been reported to be negligible. Nevertheless, other studies have found that the intraocular pressure measured on non-contact tonometry through soft contact lenses is altered and that the changes depend on the lens power, curvature, thickness and rigidity. All these critical points strongly motivate the need of methods for an accurate local mechanical and thermal characterization of contact lenses. The current mechanical characterization technique is to cut a rectangular strip before measuring the stress-strain relationship using a standard universal testing machine. The elastic modulus and Poisson ratio can thus be deduced from the data obtained. Obviously such a destructive technique cannot be applied when the contact lens is on the cornea. We introduce here a photothermal method to perform the non-destructive evaluation of the thermoelastic properties of the contact lenses. The method is based on the photothermal deflection technique where a pump laser beam is focus onto the sample so to induce a surface thermoelastic displacement. A probe beam is sent to the deformed area of the sample which causes a change in the direction of the reflected probe beam, easily detected by a position sensor. By scanning the whole area it is possible to reconstruct and map the shape of the induced displacement. Preliminary measurements performed on various contact lenses show how is possible to detect displacements of the order of a few Angstroms and evaluate the thermal expansion of the lenses. In this work we will also discuss and compare the results obtained on several soft and hard contact lenses.