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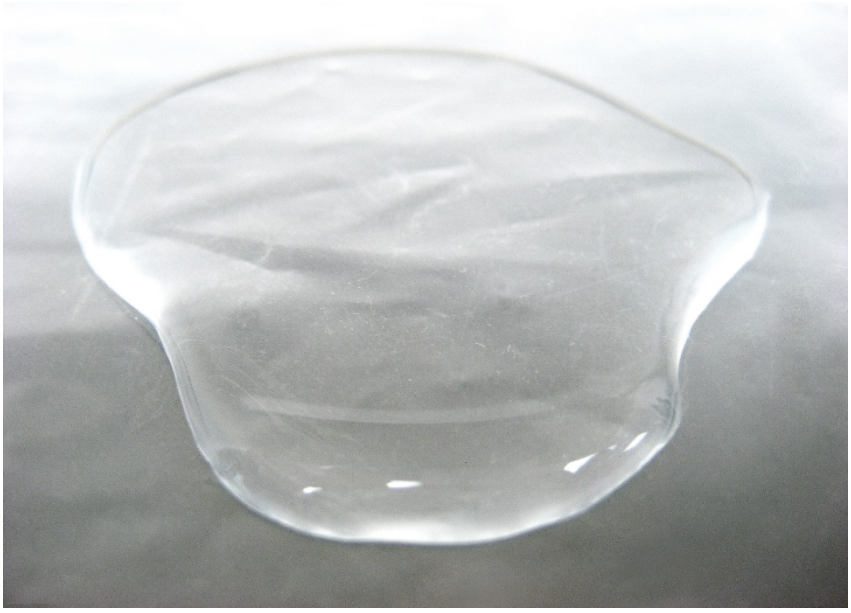
A Better Measure.

COEFFICIENT OF FRICTION OF EYE DROP SOLUTION



Prepared by
Duanjie Li, PhD & Jesse Angle

6 Morgan, Ste156, Irvine CA 92618 · P: 949.461.9292 · F: 949.461.9232 · nanovea.com

INTRODUCTION

Eye drop solutions have many different applications ranging from contact cleaner, artificial tears for allergies, to prescription drops for eye infections. The majority of eye drop solutions are sold without a prescriptions and are intended to provide the consumer relief from eye irritation. Both the effectiveness and comfort in the eyes determine which product the consumers will want to purchase.

EYE LUBRICATION CONCERNS

A major concern for eye drop manufactures is how their product feels to their clients. The lubricating effect of the eye drop solution plays a critical role in the comfort of eyes. Dry eyes develop gritty and uncomfortable symptoms when there are not adequate amounts of tears to act as eye lubricants. A good eye drop solution not only retains a comfortable level of moisture in the eyes, but also helps the eyes to keep lubricated. It forms a lubricating layer to reduce the friction between the eyes and the eyelids so as to enhance comfort and relief in the eyes. Reliable lubrication evaluation in a controlled and monitored manner is in need to simulate the realistic application conditions of the eye drop solution.

MEASUREMENT OBJECTIVE

In this application, the Nanovea Tribometer is used to measure and compare the coefficient of friction of different eye drop solutions acting as lubrication.

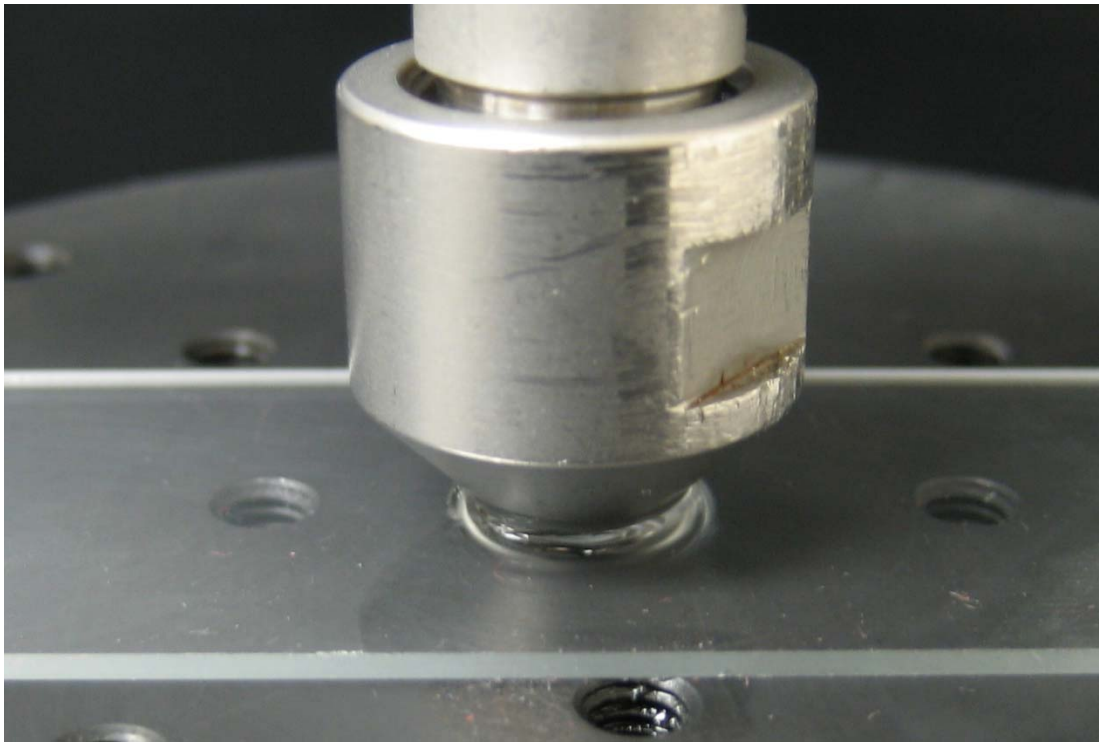


Fig. 1: The Alumina ball sliding against the glass slide immersed in the eye drop solution.

TEST PROCEDURE

The coefficient of friction, COF of the Alumina ball against the glass slide in different eye drop solutions was evaluated by Nanovea Tribometer using the pin-on-disk method. The test parameters are summarized in Table 1.

Please note that the Alumina ball as a counter material was used as an example in this study. Any solid material can be applied to simulate the performance of different material coupling under actual application conditions, such as in liquid or lubricant.

Load	1 N
Duration of test	3 min
Rotational rate	200 rpm
Radius of track	2 mm
Revolutions	600
Ball Diameter	6 mm
Ball Material	Alumina
Lubricant	A, B, C, D (respectively)
Temperature	23°C (room)

Table 1： Test parameters of the friction measurements.

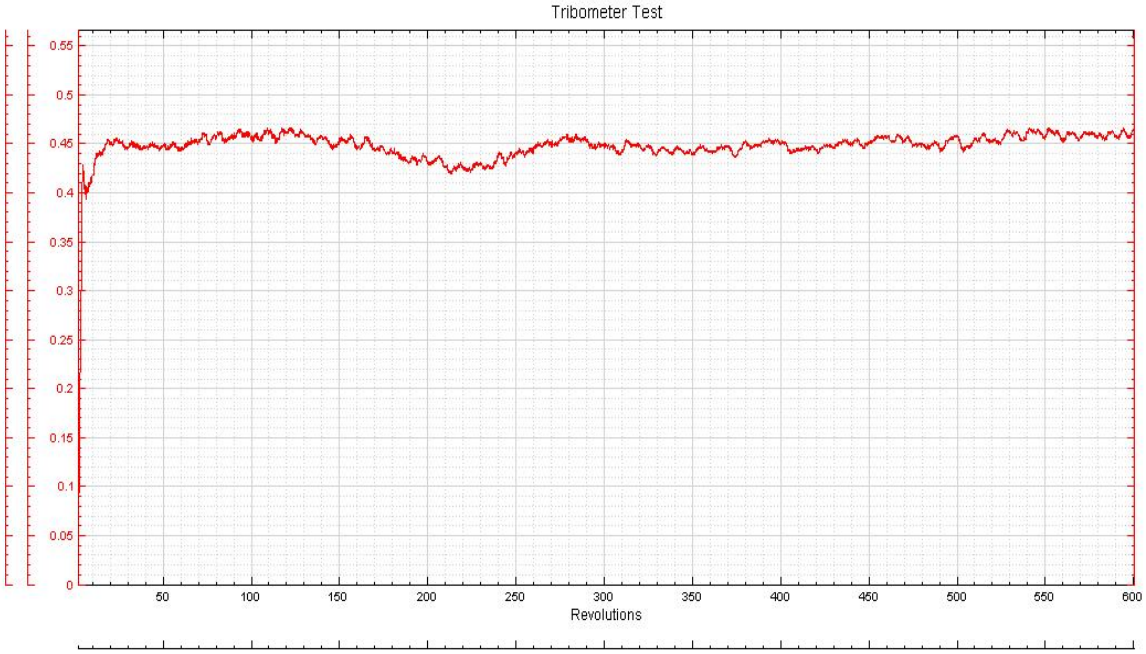
RESULTS AND DISCUSSION

Eye drop solutions are designed to prevent eye surface desiccation and reduce friction. Lubricating eye drop solution not only provides long-lasting comfort and moisture to the eyes, but also keeps the eyes protected and lubricated. The evolution of the coefficient of friction for the four different eye drop solutions as a function of the number of revolutions is compared in Fig. 2 and the average COF is summarized in Table 2. It can be observed that all the solutions act as a lubricating coating during the measurement, resulting in relatively constant COF measured throughout the tests. Sample C exhibits the lowest COF of ~0.413 during the test, indicating its better lubricating behavior. It can play a lubricating and protective role to the eye surface for eyelids to glide upon.

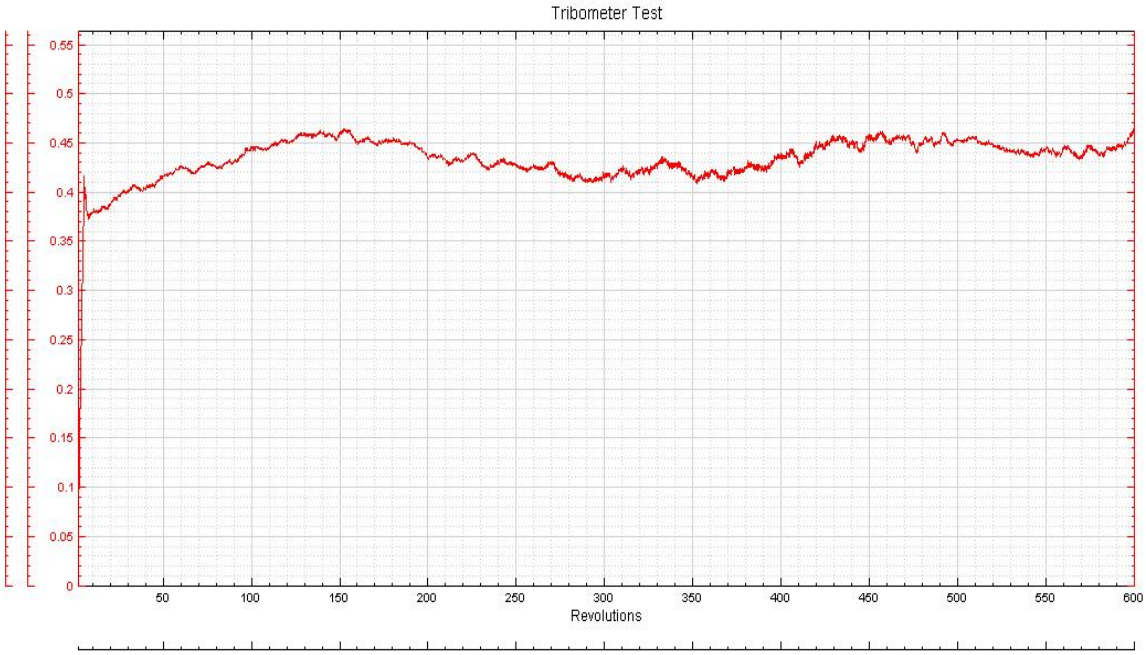
Sample	Average COF
A	0.444 ± 0.004
B	0.432 ± 0.002
C	0.413 ± 0.004
D	0.427 ± 0.002

Table 2: Average coefficient of friction during the tests.

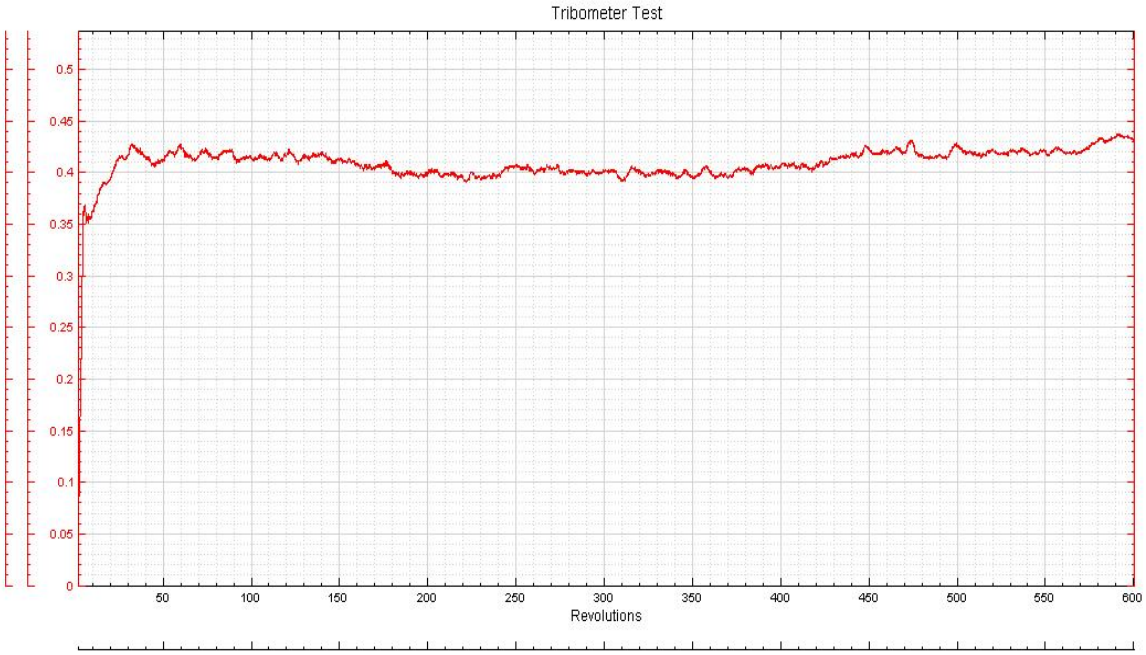
(a) Solution A:



(b) Solution B:



(c) Solution C:



(d) Solution D:

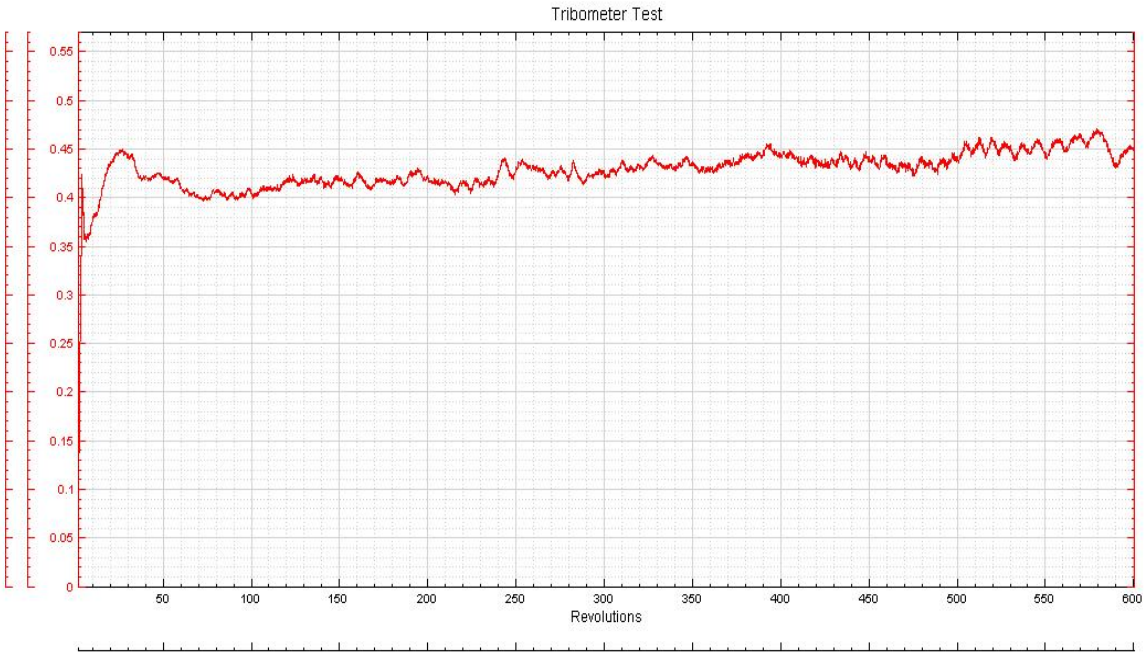


Fig. 2: Evolution of the COF as a function of the number of revolutions.

CONCLUSION

In this application, we showcase that the Nanovea Tribometer measures the lubricating effect of different eye drop solutions using a pin-on-disk setup in a controlled and repeatable fashion. The test parameters can be adjusted to better simulate real-life applications. The eye drop solutions exhibit good lubricating behavior, resulting in constant friction throughout the test. Formation of such a stable lubricating solution film enhances comfort and relief to the eyes.

The Nanovea Tribometer offers repeatable wear and friction testing using ISO and ASTM compliant rotative and linear modes, with optional Humidity modules available in one pre-integrated system. It allows users to simulate work environment of different humidity, providing users an ideal tool to quantitatively assess the tribological behaviors of materials under different work conditions.

APPENDIX: MEASUREMENT PRINCIPLE

PIN-ON-DISC WEAR PRINCIPLE

A flat or a sphere shaped indenter is loaded on the test sample with a precisely known force. The indenter (a pin or a ball) is mounted on a stiff lever, designed as a frictionless force transducer. As the plate slides in a rotational motion, the resulting frictional forces between the pin and the plate are measured using a strain gage sensor on the arm. Wear rate values for both the pin and sample may also be calculated from the volume of material lost during a specific friction run. This simple method facilitates the determination and study of friction and wear behavior of almost every solid state material combination, with varying time, contact pressure, velocity, temperature, humidity, lubrication, etc.