

Tribology Evaluation of Transparency Films with the CETR Micro-Tribometer

Summary: The tribology properties of the transparency films were evaluated with the UMT Series Micro-Tribometer. Friction tests at constant load and variable sliding speeds were performed in the Film-Film and Ball-Film interfaces. Both static and dynamic values of coefficient of friction were monitored. The substantial differences in tribological properties between two sides of the Transparency Films were demonstrated.

Instrumentation: All experiments were conducted with the CETR UMT Series Micro-Tribometer. This precision tribometer provides the accurate measurements of the tribological properties of metals, plastics, paper, composites, thin and thick coatings, solid lubricants, oils and greases. The following parameters can be measured:

- 1 - Friction force and coefficient of friction,
- 2 - Adhesion force,
- 3 - Wear and wear rate (including fatigue, abrasive and adhesive wear),
- 4 - Contact resistance or capacitance,
- 5 - Temperature in the friction zone,
- 6 - Contact acoustic emission.

The UMT can accommodate both upper and lower specimens of wide variety of shapes and dimensions (Figure 1). The upper specimen is connected to the vertical linear motion system that has a travel more than 100 mm with resolution of 1 μm (optional 50 nm).

The lower specimen is fixed on the rotating table that has velocity range from 0.05 up to 5,000 rpm (the rotation is used for positioning and/or tribological measurements). The ultra-accurate strain-gauge sensor performs simultaneous measurements of the normal load

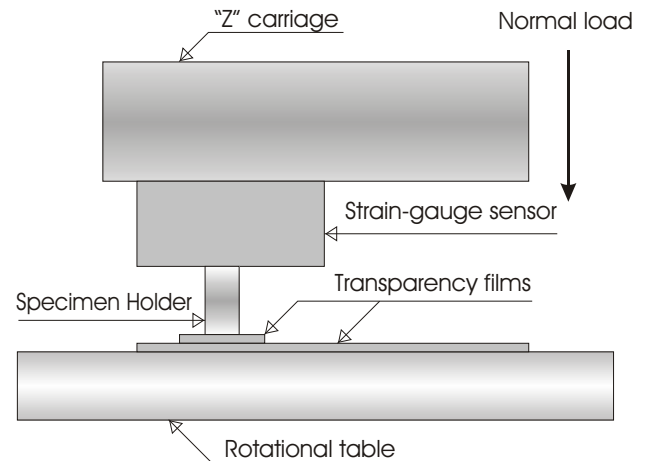


Figure 1. Schematic of friction test with Transparency films.

and the friction force up to 100 N with very high resolution and repeatability. The normal load sensor provides feedback to the vertical motion controller, actively adjusting the upper specimen position to control the load during testing. The tester has fully automated PC-based motor control and data acquisition, with a user-friendly software interface in Windows 95 multitasking environment.

Experimental procedure: In this experiment both sides of the commercial Transparency Films were tested. The tests were done at the constant load of 20 cN and variable sliding speeds from 1 to 630 cm/min. (Surely, the load and velocities can be changed per customer request). Each test consisted of starting after a short 3-sec stationary contact and then running at different speeds, with continuous normal-load and friction-force measurements and monitoring both static (breakaway at startup) and dynamic (average at given speed) values of the coefficient of friction (COF).

1. Friction in a Film-Film Interface:

Three combinations of friction surfaces were tested:

- side 1 of upper film on side 1 of lower film (1/1);
- side 2 of upper film on side 2 of lower film (2/2);
- side 1 of upper film on side 2 of lower film (1/2).

Figures 2 and 3 present the results. One can notice the following:

- a – static values of COF were higher than the dynamic values, which is well expected,
- b – the largest difference between the static and dynamic friction values was observed for the 1/1 interface,
- c – the 1/1 interface had the highest both static and dynamic friction values, while both the 1/2 and 2/2 interfaces showed lower friction similar between two of them.

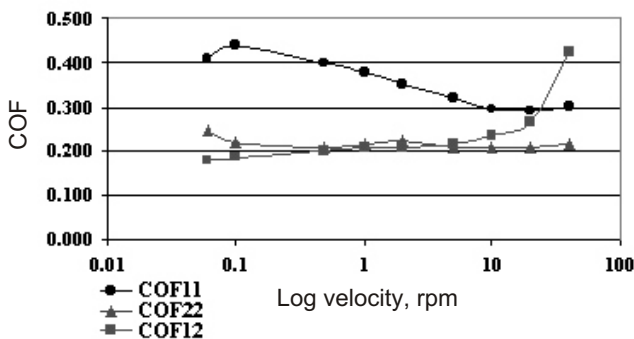


Fig. 2. Static COF versus velocity: first similar sides (11); second similar sides (22); different sides (12).

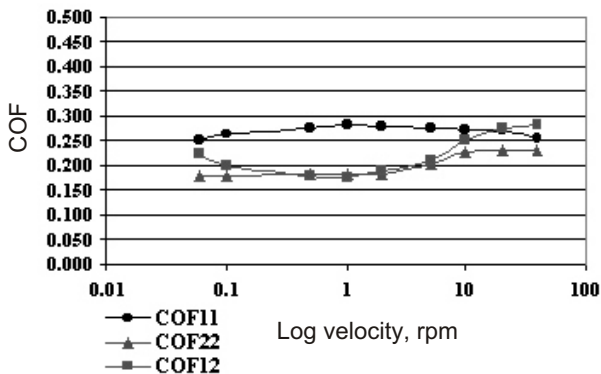


Fig. 3. Dynamic COF versus velocity: first similar sides (11); second similar sides (22); different sides (12).

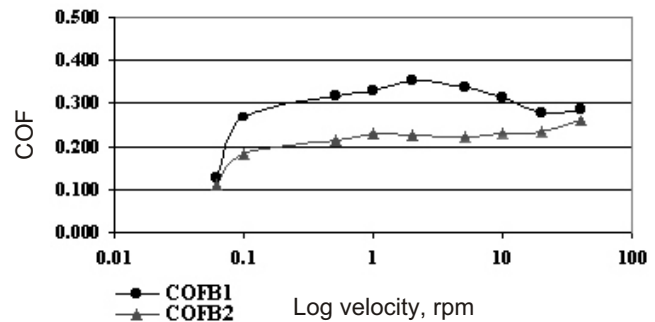


Fig. 4. Static COF versus velocity: ball on film

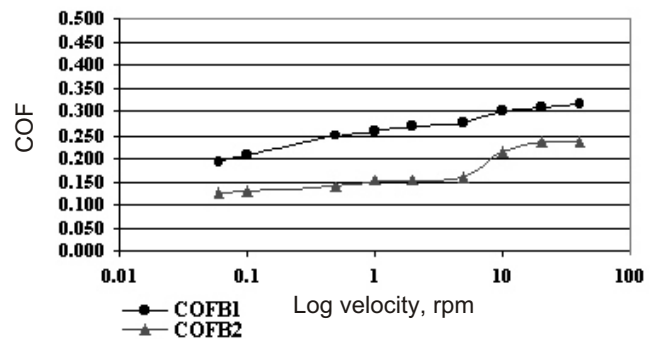


Fig. 5. Dynamic COF versus velocity: ball on film

2. Friction in a Ball-Film Interface:

4-mm stainless steel balls of Rockwell hardness C62 were used. Two combinations of friction surfaces were tested:

- ball on side 1 of lower film,
- ball on side 2 of lower film.

Figures 4 and 5 present the following results:

- a – the difference between static and dynamic friction values is much smaller and practically insignificant, which is also well expected and due to the much smaller area of contact than that in the first series of tests;
- b - side 1 of the films consistently exhibited higher friction than that of side 2, which is in agreement with the first series of tests.

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