Tribological comparison of three typical wrinkled surface on the elastomeric polymer

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1. Introduction

Surface texturing has been known as an effective way to improve tribological performance [1]. To obtain given texturing patterns, a variety of conventional fabrication techniques were applied to make desirable surface. Recently surface wrinkling has been utilized as a novel approach to create various and ordered surface structures for mico-fabrication [2, 3]. The preliminary work in friction of wrinkled surface has been carried out [4, 5]. In this manuscript, three typical winkled surfaces were delicately modulated and evaluated for comparison of tribological performance.

2. Experiments

Firstly an elastomeric polymer (Polydimethylsiloxane, PDMS) sheets were prepared. These sheets were stretched to 10%-30% in homemade stretched platform. The metal thin films of 10~100 nm thick were deposited onto the surface of these pre-stretched PDMS sheets in ambient temperature by ion sputtering. According to given winkle patterns, selective controlling releasing was implemented. Finally tribological experiments were carried out in the ball-disk tester. Optical microscope and atomic force microscope were used for measure.

3. Result and discussion

3.1 Formation and modulation of surface wrinkles

The wrinkle patterns mainly rely on the local distribution of compressive stress. Here we applied given pre-stretch on PDMS sheets in uniaxial or biaxial direction. After deposition, controlled releasing was made simultaneously or sequentially, and stripe, labyrinth, and herringbone patterns were obtained respectively, shown in Fig.1 (a)-(c).

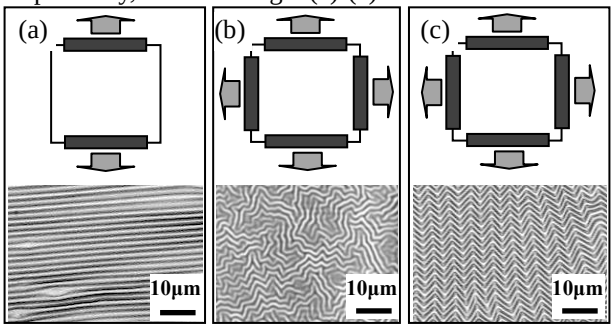

Fig.1 Typical wrinkled patterns: (a) striped patterns made by uniaxial pre-stretching and releasing; (b) labyrinth ones by biaxial pre-stretching and simultaneous releasing; and (c) herringbone ones by biaxial pre-stretching and sequential releasing.

3.2 Tribological performances

On the basis of the experimental data and previous theory, the wavelength and amplitude of wrinkle patterns are mainly related to the thickness of the film, substrate temperature, elongation and deposition rate, and so a series of buckled surface could be created for tribological comparison research. Under the desirable experimental condition, three typical wrinkled patterns had the uniform aspect ratio, and tribological comparable tests have been carried out in the sliding direction perpendicular and parallel to the raised lines. The experimental results indicate that wrinkled surface all reduce coefficient of friction. It is more important that labyrinth patterns have the uniform frictional behavior in two directions, but stripe and herringbone have strong direction dependency.

4. Conclusion

Three typical wrinkles could exactly be made by controlled stretching and releasing. All of these winkled surfaces could effectively improve frictional performance. But stripe and herringbone patterns both have anisotropic tribological behavior compared with labyrinth ones.

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6. References

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