

Project A38

Inter-laboratory study: elastic modulus measurement for compliant materials using an atomic force microscope

Objectives

The aim of this inter-laboratory study is to compare the elastic modulus of compliant materials calculated by the linearized JKR method¹, which was developed recently, with that by the two-point JKR method² adopted in the procedure of [ISO 21222:2020](#).

The results of the study will be used for the future revision of ISO 21222.

Background

AFM force-distance curve measurements are used to determine the elastic moduli of compliant materials such as organics and polymers at surfaces. The moduli are calculated from the curve fitting of a contact mechanic model to the curves. It is necessary to select a proper contact mechanic model and to use an appropriate calculation procedure.

Standardization Needs

The recently published ISO 21222:2020 'Procedure for the determination of elastic moduli for compliant materials using atomic force

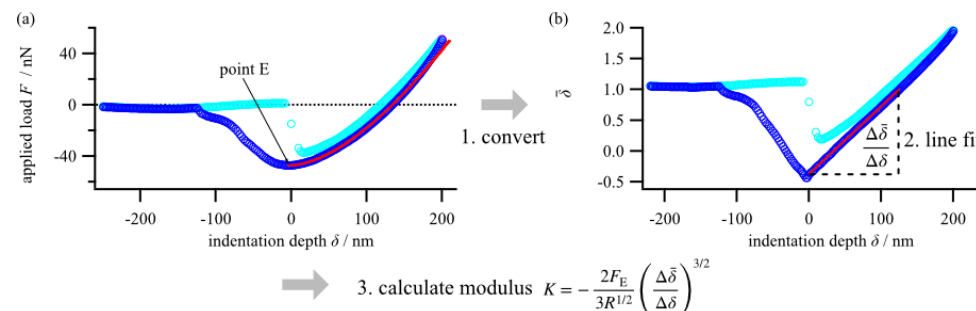
microscope and the two-point JKR method' employs the two-point JKR method for modulus determination, as its title indicates. This method is very simple and easy to use but there are several limitations. Only two points of the curves can be used and thus, the calculated modulus tends to be affected more by noise on the curve than conventional curve fitting which involves more data points. Another limitation is that the force region used in fitting is fixed and thus, the repulsive force region cannot be involved in fitting.

Recently the linearized JKR method was developed, which is free from these limitations but still easy to use. It is expected that introducing the linearized JKR method improves the applicability of the modulus determination. This inter-laboratory study aims to validate the advantages of the linearized JKR method over the two-point JKR method.

Work Programme

Two kinds of compliant samples having different elastic moduli will be delivered together with cantilevers for the respective samples. Participants will be asked to perform multiple force-distance curve measurements on the

Call for Participation



(a) Example force-indentation curve on PDMS and (b) its linearized form calculated during the linearized JKR method procedure.

provided samples with the provided cantilevers under atmospheric conditions and to report the elastic moduli calculated from the method described in the protocol that will be delivered later.

Deliverables and Dissemination

Results that evaluate the variance of the elastic modulus calculated from the respective methods will be reported in International Symposium on SPM Standardization. Results will be also published in a peer-reviewed journal and will be used in the future revision of ISO 21222.

References

- [1] Fujinami, S., Ueda, E., Nakajima, K., Nishi T., *J. Polym. Sci. Part B Polym. Phys.*, 57, 1279–1286 (2019).
- [2] Sun, Y., Akhremitchev, B., Walker, G. C., *Langmuir*, 20, 5837–5845 (2004).

For more information on participation, please contact:

Prof. So Fujinami
Kyoto University, Japan
Email: fujinami.so.8z@kyoto-u.ac.jp

Prof. Ken Nakajima
Project Leader,
Tokyo Institute of Technology, Japan
Email: knakaji@mac.titech.ac.jp

Prof. Ian Gilmore
Chair, VAMAS TWA 2
National Physical Laboratory, UK
Email: ian.gilmore@npl.co.uk

www.vamas.org