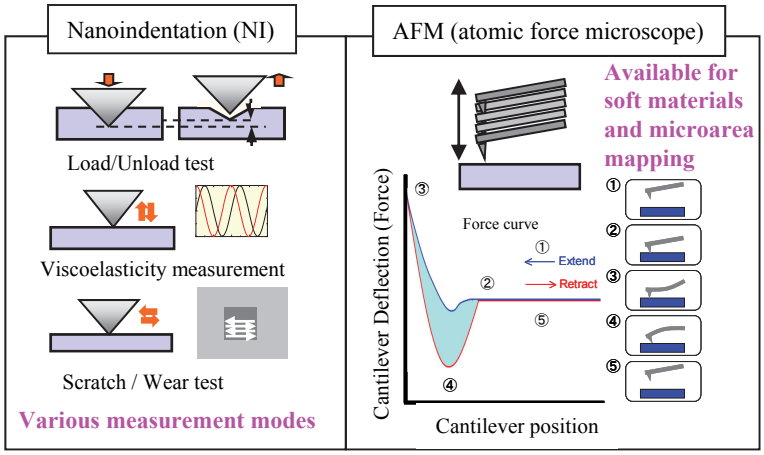
Characterization of Mechanical Properties using Nanoindentation and AFM

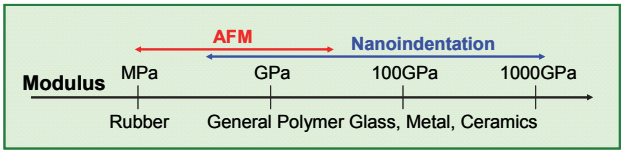
Suitable selection of Nanoindentation (NI) or AFM (atomic force microscope) force curve method enables us to evaluate mechanical properties from soft to hard materials. Nanoindentation test can be also performed under high temperature. These methods are applicable for the clues of degradation or adhesion as well as basic characterization of materials.

Principles and Characteristics



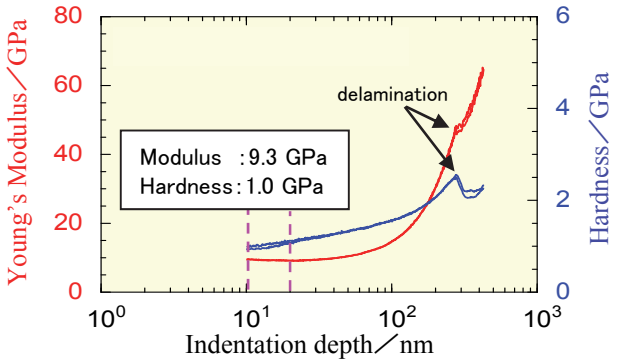
＜Applications＞

- **Modulus, hardness and adhesion of thin films**
- **Mapping of phase separation（storage, loss, tanδ）**
- **Line analyses of surface-modified samples or laminated films**
- **Mechanical properties near the interfaces with different materials**
- **Fracture toughness, wear resistance etc.**



Mechanical properties of thin film by NI

＜Sample：Organic film on Si substrate (500 nm thickness)＞

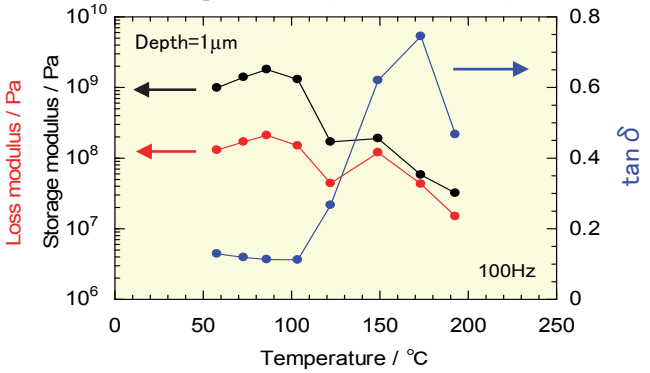


Modulus of a ultrathin film can be estimated by approximate equation. Folding point (arrow in the figure) indicates the comparative evaluation of the adhesion between film and substrate[1].

1)M.Takeda et.al, J. Mater. Res., Vol. 25, No. 10, Oct. 2010,1910-1916.

NI under high temperature

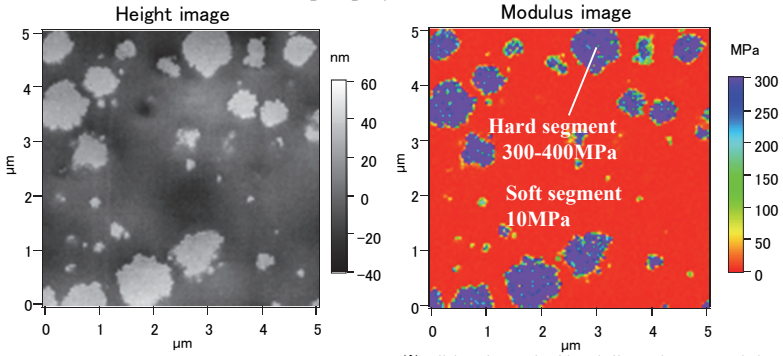
＜Sample：PMMA (200 mm thickness)＞



Viscoelasticity at high temperature can be obtained using NI. This method is beneficial for characterization or degradation analysis of thin film, micro material, and specific micro area.

Modulus image of soft material by AFM

＜Sample：polyurethane＞



Refined analyses of AFM force curves enables us to estimate the modulus of soft materials, which was difficult to obtain by Nanoindentation. Evaluation of mechanical properties in micro area with high resolution is available for various characterization, for example, analyses of soft and thin films, phase separation (sea-island structure or compatibility), and resin / resin interfaces.

※Collaborative work with Nakajima Laboratory, Tohoku University