Mechanical-Property Mapping of Automotive Plastic Materials Using SIS-ACCESS
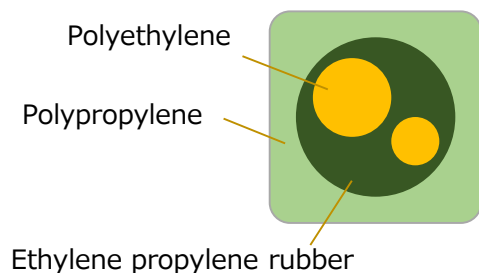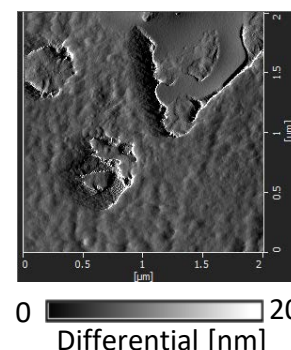
SHEET No. 019
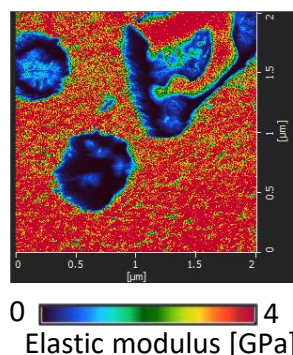
SIS ACCESS

Polyethylene

Polypropylene

Ethylene propylene rubber

(a) Structure of ternary polymer blend

0 ▮▮▮ 280
Height [nm]

(b) Topographic

0 ▮▮▮ 20
Differential [nm]
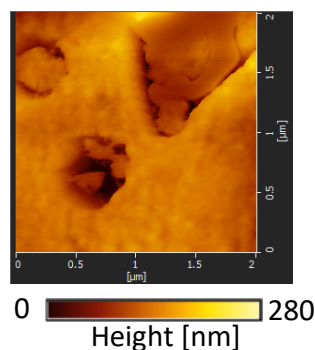
(c) Differential

Result of elastic modulus*
PP   1 GPa
PE   0.2~0.3 GPa
EPR   1~10 MPa

0 ▮▮▮ 4
Elastic modulus [GPa]

(d) Elastic modulus

0 ▮▮▮ 37
Deformation [nm]

(e) Deformation

0 ▮▮▮ 7.5
Adhesion [nN]

(f) Adhesion

0 ▮▮▮ 1
Dissipation [arb.]

(g) Dissipation

Elastic modulus   Deformation
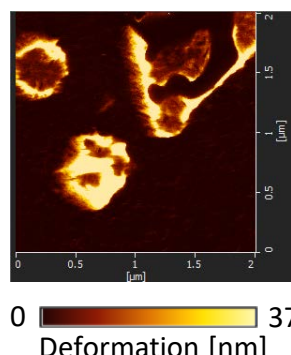
Adhesion   Dissipation
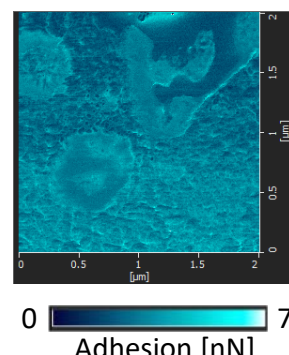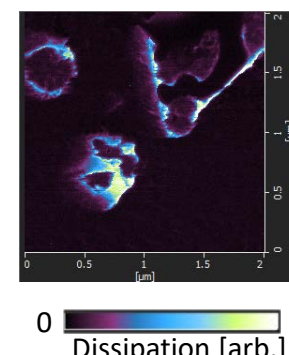
Fig.2 How to analyze force curve

*note: SIS-Quantimech (Optional) is necessary for analysis of elastic modulus image.

Fig.1 Mechanical-property mapping of ternary polymer blend   Model AFM5300E

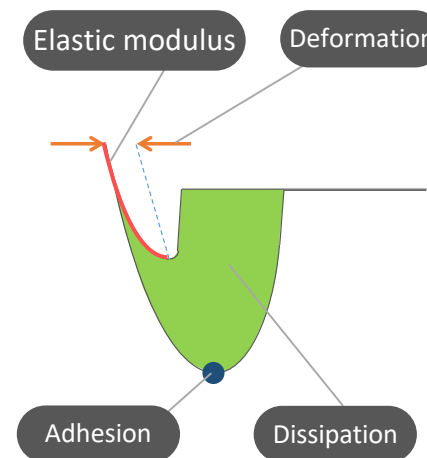SIS-ACCESS extends the capabilities of Sampling Intelligent Scan (SIS) and enables the simultaneous acquisition of up to 8 data channels on surface topography and various physical properties (both mechanical and electrical properties). By measuring both force curves at each pixel and retracting the probe from the sample when moving between pixels, the physical property mapping image can stably obtained without damaging the sample even with soft materials such as polymer or rubber.

Fig. 1 shows the results from using SIS-ACCESS on a plastic material that is utilized in the auto industry. As shown in Fig. 2, multiple physical properties can be derived from the force curve measured at each pixel, proving that ethylene propylene rubber (EPR) is much softer than the polypropylene (PP) matrix, and corresponding deformation, adhesion, and dissipation signals in EPR regions are significantly higher than those in PP matrix . In addition, the elastic modulus of polyethylene (PE) is intermediate between PP and EPR. Based on these observations, the three components can be differentiated and their compositional mapping at sub-micrometer scale can be achieved.

*Data provided by Mr. T. Nakashima and Dr. Y. Namai of Mitsui Chemical Analysis & Consulting Service, Inc.

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Measurement of Mechanical-Property Mapping of Automotive Plastic Materials Using SIS-ACCESS

Science for
a better tomorrow

Recommended configuration	Remarks
Environment-Control Unit AFM5300E	
Probe Station AFM5000 Ⅱ	
SIS-ACCESS	
SIS-QuantiMech	
Cantilever : SI-DF3P2	

AFM5300E

⊛ Hitachi High-Technologies Corporation