Evaluation of Adhesive Tape Surface via SPM

We are capable of sensing stickiness, hardness, softness and other physical properties of the surface of a physical object by touching it with our fingertips. With the Scanning Probe Microscope (hereafter SPM), the form of a surface can be observed simultaneously with the physical properties of viscosity and elasticity, using a cantilever sensor much smaller than a fingertip. The cantilever has a pointed tip, shaped like a needle. The sample is lightly struck by this pointed tip, and evaluation of the reaction enables assessment of the physical properties of viscosity and elasticity.

In this report, three types of commonly used adhesive tape were selected. Focusing on their adhesive surfaces, differences in form and viscoelasticity were evaluated. 1. cellophane tape 2. strong adhesive packing tape and 3. weakly adhesive tape formed by repeated adhesion and removal were used as samples.

The SPM phase detection system was used for observation. Further, the area of the portion with strong adhesive strength was found using particle analysis software.

Generally in observation of strongly adhesive surfaces, there is a tendency for the cantilever to become trapped. However, observation was enabled by the SPM stabilized cantilever control system.

1. Observation of the Adhesive Surface of Cellophane Tape

The adhesive surface of cellophane table was observed. Fig. 1(a) is an observation of the roughness of the surface in the form of a 3D image. (b) is a viscosity image at the same position as in (a). The dark part indicates strong adhesion.

If the surface roughness is shown in terms of average roughness (Ra), the value is evidently a very small, flat 4 nm. Further, as more than 90% is strongly adhesive, we can say that this is a strongly adhesive type of tape.

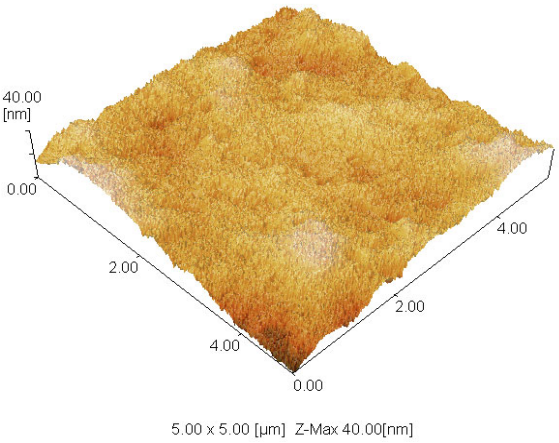

Fig. 1(a) 3D Image of the Adhesive Surface of Cellophane Tape

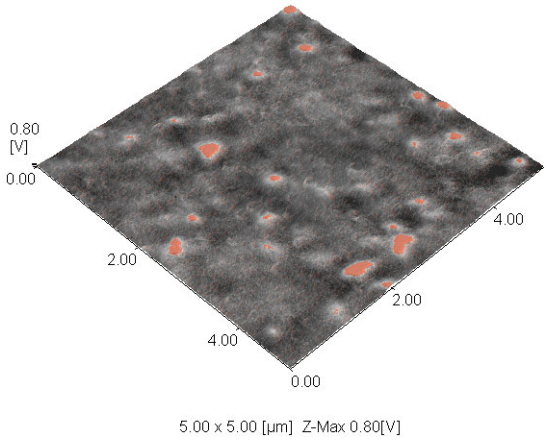

Fig. 1(b) Viscosity Image

2. Observation of the Adhesive Surface of Strongly Adhesive Tape

So-called rubber tape was observed as a typical example of packing adhesive tape. The merits of SPM are also shown in observation of strongly adhesive surfaces. Fig. 2(a) is a 3D image of a strongly adhesive surface. Fig. 2(b) shows the viscosity. If we investigate the roughness and adhesive surface from the image, it is evident that the properties are similar to that of cellophane tape.

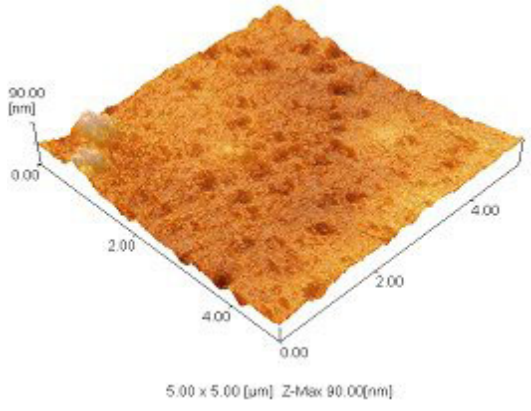

Fig. 2(a) 3D Image of the Adhesive Surface of Strongly Adhesive Tape

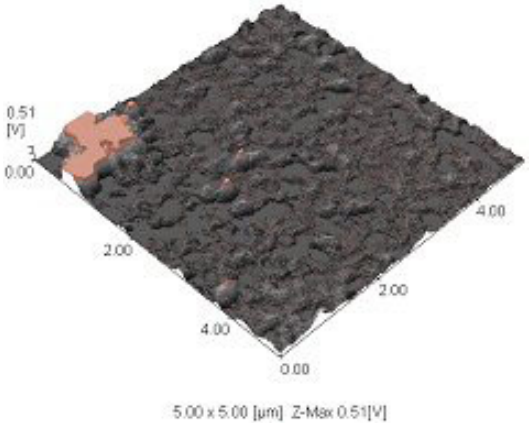

Fig. 2(b) Viscosity Image

3. Observation of the Adhesive Surface of Weakly Adhesive Tape

The weak adhesiveness of the weakly adhesive tape was observed by investigating the adhesive surface roughness and adhesive area in comparison with cellophane tape.

Fig. 3(a) is a 3-dimensional image of the adhesive surface. The average roughness is a large 171 nm – a value approximately 40 times that of cellophane tape – and significant roughness of the surface is evident.

Fig. 3(b) is a viscosity image. With the viscosity image, observation showed that the dark parts are extremely small. This is the result of dispersal of filler over the surface in order to minimize the adhesive surface area. As a result, the area contributing to adhesion is about 40% of the total, which means less than 1/2 the adhesive strength. This compares with 90% for cellophane tape, assuming the same adhesive material.

From these results, inspecting both (a) the 3D image and (b) the viscosity image, it is evident that there are large rises and projections on the adhesive surface. Weak adhesiveness has thus been obtained by reducing the contact area with the target object and by minimization of the adhesive surface area through dispersion of filler.

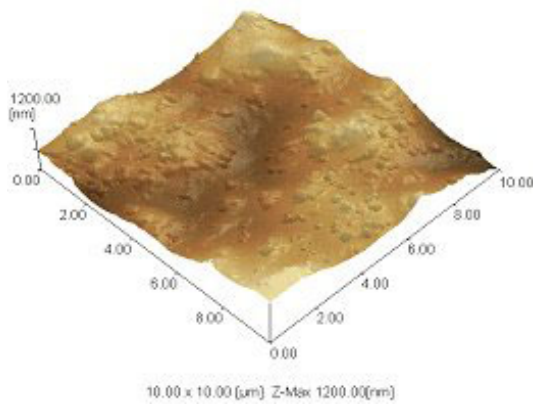

Figure 3(a) 3D Image of the Adhesive Surface of Weakly Adhesive Tape

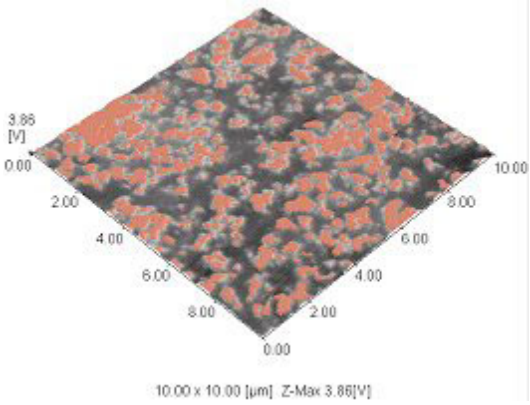

Figure 3(b) Viscosity Image