Micro Materials
Excellence in Nanomechanics

Humidity Cell

Investigate how the mechanical properties of your surfaces are affected by humidity

The properties of many materials can vary significantly with changes to humidity. This can be especially true of polymeric or biological samples. Obtaining meaningful test results for prediction of true-life performance is better achieved by closely simulating service conditions. The rapid change Humidity Cell module can assist considerably in achieving this.

Suitable for investigating the effect of humidity in:

- *Biological studies*
- *Polymer films and nanocomposites*
- *Tribology of biomaterials*
- *Nano and Micro-friction in sliding wear*
- *Cementious materials*
- *MEMS/Microelectronics*

How it works

Important features of humidity cell experiments with the NanoTest Vantage

The humidity cell utilises a small external water vapour generator linked to a controller to provide the required humidity in the test cell. An in-line desiccant is also present to pre-dry the air prior to controlled steam addition. A full range of humidity from 10% to 90% is therefore possible, irrespective of ambient room conditions.

- **Fully programmable experimental conditions:** The humidity cell has its own controller allowing simple set point and display of relative humidity (RH).
- **Chamber design:** The humidity cell is designed to be small enough to allow rapid attainment of set point and stabilisation, whilst also being able to accommodate the sample and indenter.
- **Test versatility:** The cell allows a full range of tests to be performed on samples under controlled humidity. These include indentation, scratch and high strain rate impact.

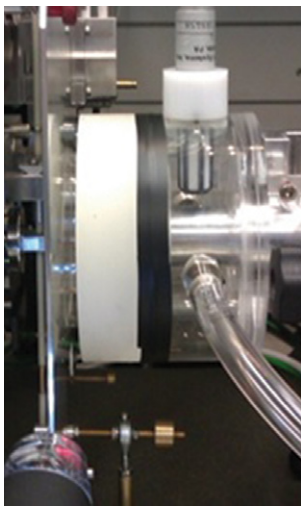

Figure 1 the Humidity Cell on the NanoTest

Coated glass exposed to varying humidity

Figure 2 demonstrates that the effects of humidity are not always predictable.

On a multi-layer coated glass sample there is a marked change in increasing from 5% RH to 30% RH, but little effect when the RH is increased further.

Even at 90% RH the decrease in hardness is negligible compared to 30% RH.

Results such as these emphasize the importance of testing under the correct humidity level rather than relying on linear extrapolation.

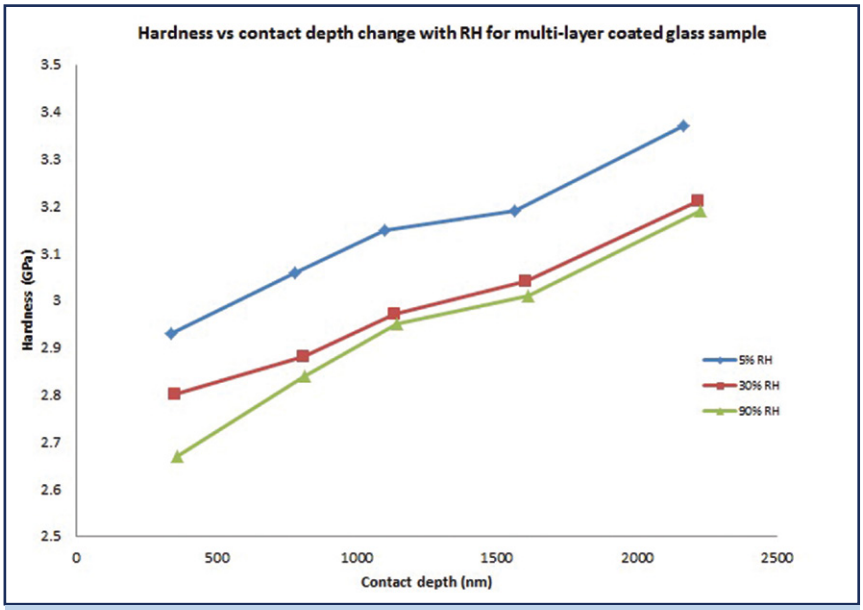

Figure 2 shows results from a multi-layer coated glass sample. The significant change in hardness when tested between 5% RH and 30% RH contrasts with the negligible change induced by increasing RH further.

Effects of changing humidity on polymeric sample

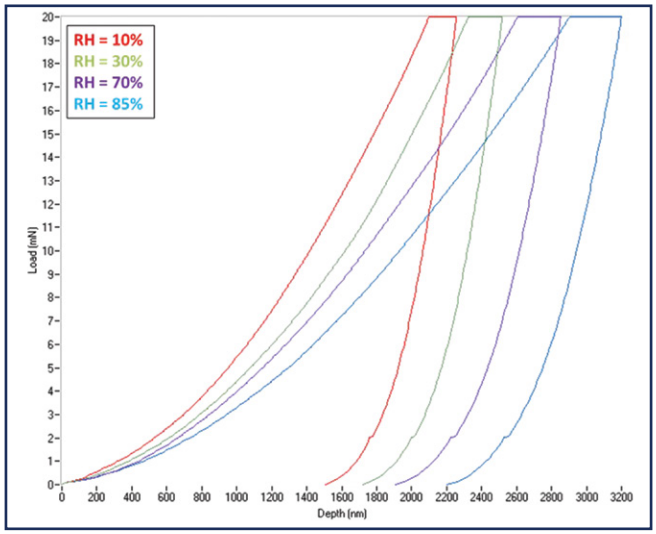

Figure 3 shows the changing nanoindentation response for a polymer nanocomposite with 10% clay tested under varying humidity conditions.

The results shown in Figure 3 demonstrate the effect varying humidity can have on the properties of polymeric materials.

In this example, the contact depth increases significantly with increasing humidity, an effect that may be missed without thorough, relevant testing.
There is also a clear rise in the depth increase during the 60s hold at peak load indicating that the material is creeping more.

The small volume and rapid speed of humidity change is important as it allows the kinetics of moisture uptake processes to be studied. The wide load range of the NanoTest loading head allows kinetics of these diffusion processes to be studied by allowing very shallow and very deep indentations with the same loading head.

Figures 4 and 5 show the hardness and modulus of nylon and nylon plus 10% clay nanocomposite, both plots highlight a clear trend.

Both hardness and Young's modulus decrease as the relative humidity increases although this drop is not linear, again highlighting the benefits of testing in relevant conditions over extrapolation.

Results from the composite with 10% clay have been compared to those from an untreated nylon sample. These show that the benefits given by the clay are maintained even at higher humidity.

This allows direct assessment of the usefulness of the nano-composite in humid conditions.

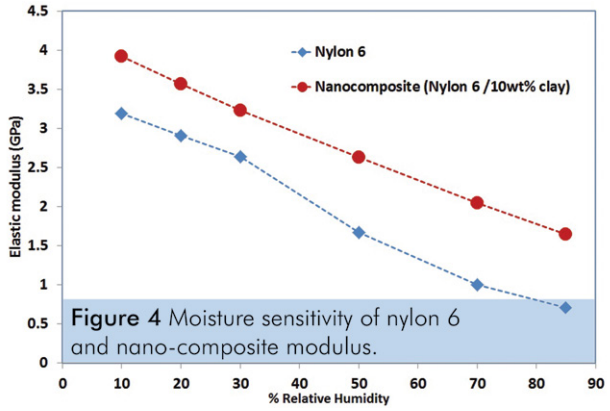

Figure 4 Moisture sensitivity of nylon 6 and nano-composite modulus.

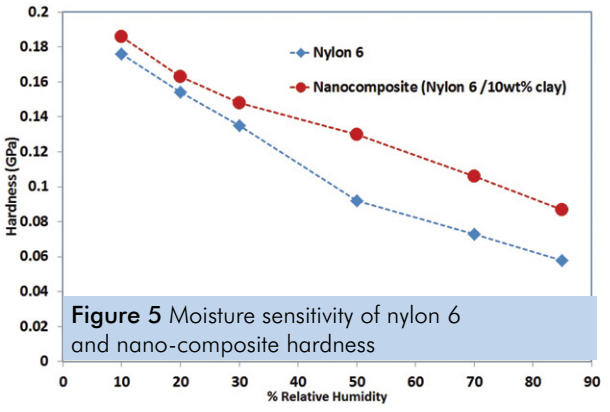

Figure 5 Moisture sensitivity of nylon 6 and nano-composite hardness

Advantages

- Simple set up
- Rapid control of humidity from 10% RH to 90% RH
- Desiccant drying and water vapour humidification allow consistent RH to be held irrespective of ambient conditions
- Full range of tests possible within the Humidity Cell, indentation, scratch and impact
- Available on new instruments or as an upgrade

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NanoTest™ Vantage