NANO INSTRUMENTS

APPLICATION NOTE
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COLOR TONER / PAPER BOND STUDY
APPLICATION

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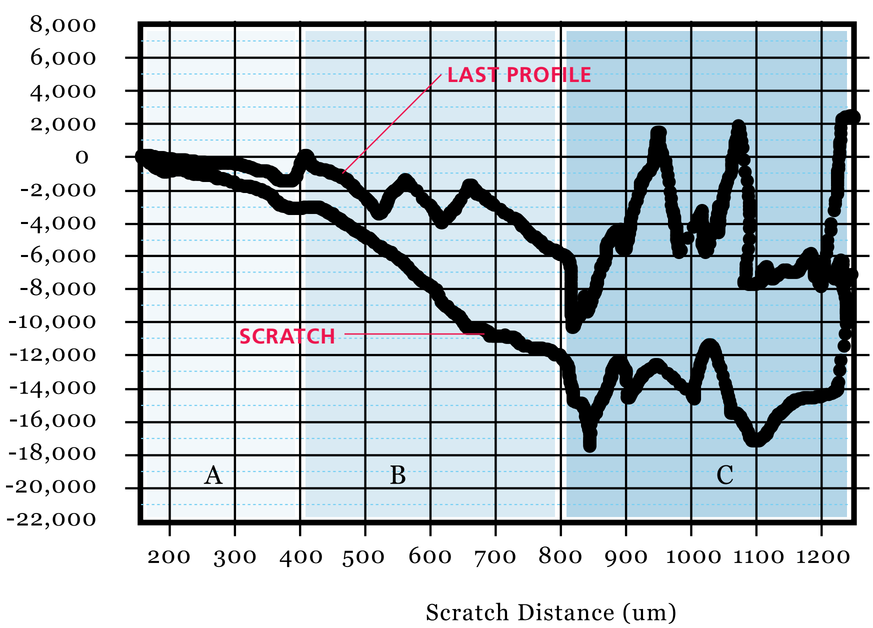
INTRODUCTION

A customer from the printing industry approached us with a need to test different types of color toner deposited on paper substrates. This application note briefly describes the successful solution achieved using the Nano Indenter XP and its scratch capability.

figure 1: Penetration curves during the scratch & last profile (nm)



THE PROBLEM

In order to insure the durability of colors in the printed form, a strong bond is required between the color toner and the paper to which it is applied. Therefore, the customer desired a technique for evaluating adhesion between various color toners and paper types. Such information would allow accelerated product development. As an initial test case, the customer wanted to evaluate toner adhesion among 4 different toners on the same paper type.

THE SOLUTION

From our line of indentation systems, the NANO **Indenter** XP was selected as the hardware base due to its scratch capability, unique combination of robust construction, large displacement travel (2 mm), and excellent resolution in both force and displacement (50 nN an 0.01 nm, respectively). A conical diamond was installed as the scratching tip. The pieces of paper were mounted on glass microscope slides.

The scratch is composed of four phases:

- An initial profile is realized under a small load (50µN) along the future scratch path. This profile provides the original morphology of the surface.
- Then, along the same path, the normal load is increased from 0 to 300mN to create the scratch. The ramping of the load increased the severity of the contact.
- A final profile is realized under a small load (50µN) in order to measure the residual deformation left in the material.
- A cross profile can be performed at 90 degrees in the section of the scratch that is plastically deformed (and not fractured) in order to evaluate the plastic deformation.

RELATED PRODUCTS:

NANO **Indenter** XP

TestWorks®

MTS®

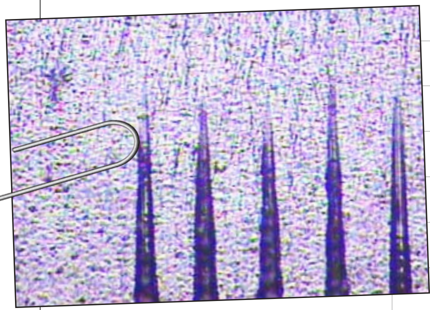


figure 2: Scratches on black toner

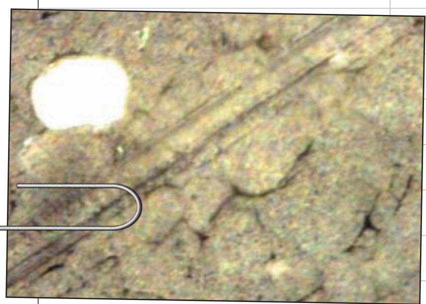


figure 3: Plastic deformation

figure 4: Fractured zone

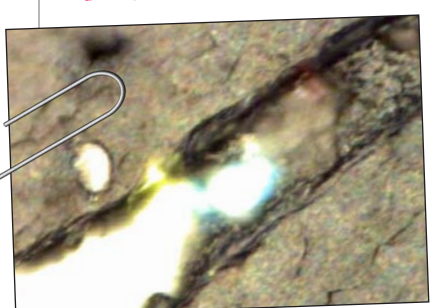


figure 5: Delamination

THE RESULTS

Five scratches (figure 2) were run on each of the 4 samples. As the load increases on the conical tip, the deformation of the toner first goes from elastic to plastic. After the plastic deformation, as the load continues to increase, the toner reaches a point where it can no longer accommodate the contact pressure by plastic deformation alone. This point is the start of fracture. At this point the toner begins to crack and ultimately delaminates from the substrate. Figure 1 presents the scratch penetration and the profile showing the residual deformation directly from the review page of **TestWorks**. Three zones can be observed on the plot and in the optical observation (figure 3 - figure 5):

- A plastic zone (zone A on figure 1),
- A fractured zone where the toner is cracked and chipped (zone B on figure 1),
- A delaminated zone where the toner is peeled off from the substrate (zone C on figure 1).

The load at which the sample begins fracturing is called critical load. The critical load of each sample was compared to evaluate its scratch resistance (figure 6).

CONCLUSIONS

The toner scratch resistance was evaluated through the critical load. The samples were ranked as a function of their critical loads. The presentation of the results aligned with and confirmed the customer's expectations. The great versatility of the NANO **Indenter** XP allows both indentation and scratch tests. This powerful range of capability supports investigation of different material properties near the surface.

TestWorks software, unequaled in the nano testing industry, allows a real time display of the measurements during the experiment as well as a complete and easy review of the results after the test. Our engineers are able and willing to work with you in the development of custom **TestWorks** methods to suit your unique testing needs.

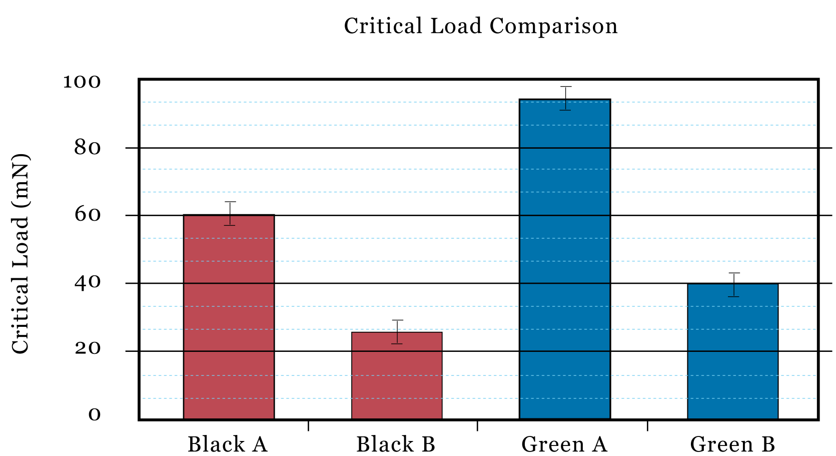


figure 6: Difference in scratch resistance for the 4 samples.

Inspired science.

Characterizing surfaces down to the level of a few nanometers has become increasingly important for a wide range of manufacturers and researchers. Properties at the nano scale can affect the performance of a variety of scientific and consumer products. NANO **Indenter** systems from MTS NANO INSTRUMENTS use the most advanced technology available to acquire fast, accurate mechanical data on a variety of surfaces at the submicron scale.

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