MiCROVISION LABORATORIES, INC.

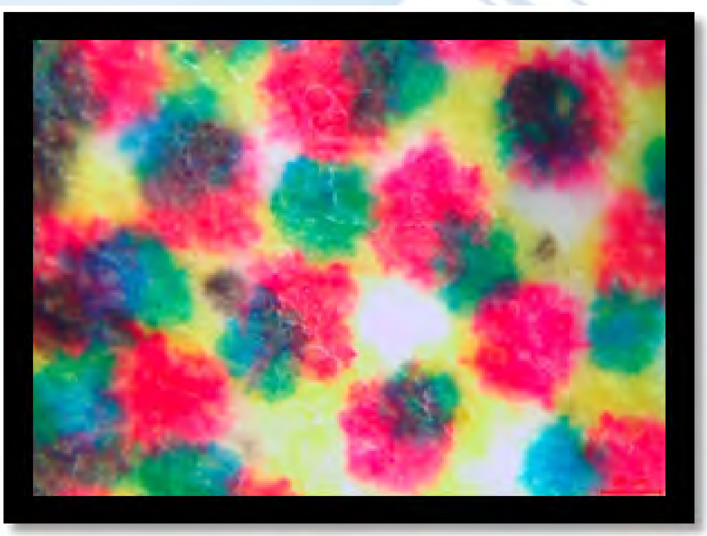
The Anatomy of a Playing Card

(part 1)

The purpose of this examination is to highlight and demonstrate analytical techniques that can be used in the graphic arts medium. A playing card is an excellent example of something so commonplace that one normally does not associate it with any sophistication at first glance, but in reality they have a complex structure and engineering behind them.

Like any engineered product, the components in the card are all included in order to address particular needs in the end product. First off, you need the cards to be of a certain stiffness and thickness to hold up to being bent but not so bulky that they cannot be shuffled. Then there is the issue of being opaque. Even though the chances of seeing through 10 point paper are next to nothing, enough fantastical ideas about exotic wavelength-viewing sunglasses in casinos have prodded guarantees to provide additional protection in the form of a black layer within the cards. The cards also need to have a very low coefficient of friction to be dealt easily and handled quickly. All of this is even outside of the making something appealing through unique print design. With advances in materials and capabilities today we see cards being dressed up with foil, lenticular printing, holographic imaging, security printing and almost any process or feature one can imagine on a card. This analysis is designed to break down how all of these interrelated components and design decisions can be examined and troubleshot using unique analytical techniques to bring out the complex details in this deceptively simple application. For our purposes we chose a fairly basic card, if that term can be even used. This was also done so as not to totally give away any trade secrets should the producer of the card be identified.

We propose to go through the card and unravel some of the mystery behind what goes into making all of these things work together. The surface and structural characteristics will be examined using Nomarski Interference Contrast (NIC) optical microscopy and Scanning Electron Microscopy imaging. Surface examination will also include Micro IR techniques to see what comprises the coating that makes it so slippery. We will also employ cross sectioning of the card itself to do elemental mapping and micro IR of the inner portion and coated surface of the card itself to show



Here are examples of how shifting the level of polarization affects the way we see the card surface

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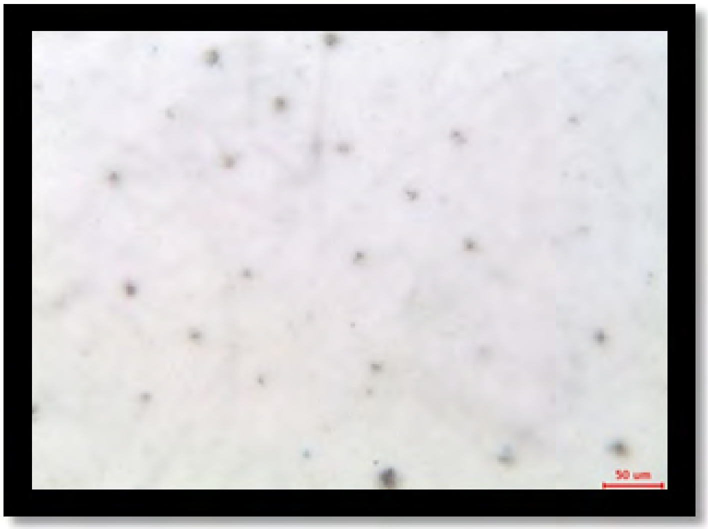
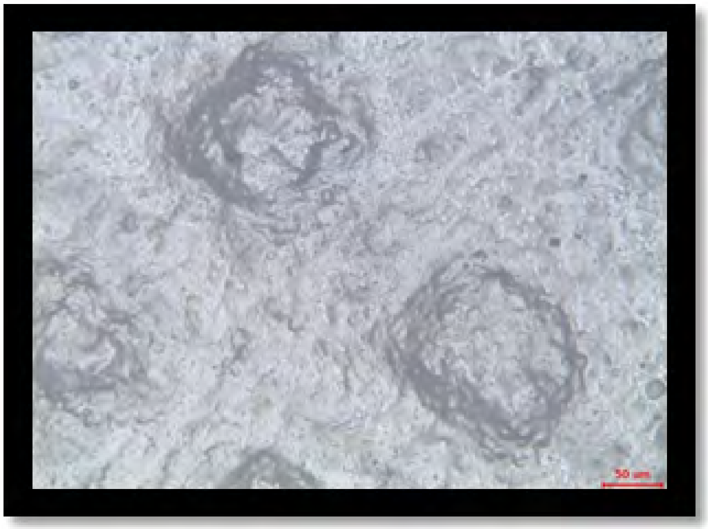
Surface examination by Polarized Light Microscopy: The contrast enhancing properties of the Polarized Light microscopy allow us to view the surface topography in a way that standard optical microscopy might not allow. In the four images below, we see a cavitation and surrounding the dimple the surface is stippled. This is by design. The dimples create air flow and turbulence between the two cards similar to what happens with a golf ball and the Bernoulli Effect so they will glide past each other.

Nomarski Interference Contrast Microscopy: This light microscopy technique is performed by modifying the path of the light source. Light is passed through a polarizing lens located behind the condenser, in a manner similar to polarized light microscopy. A prism then splits the beam into two beams in slightly different directions but perpendicular to each other. The light is unable to recombine which then causes interference. When the two beams pass over the sample their paths are further altered due to the topography of the surface and the refractive nature of the sample itself. As the beams of light enter the objective above they are recombined by a second polarizer, but the beams are no longer equidistant due to the topography of the object being examined. This creates destructive interference in the beam, which increases contrast in the image based on changes in the path-length of the two sub-beams on the order of the light wavelength. This allows for small variations in either optical index or surface topology to be brought into view that otherwise would be





Here are examples of how the use of DIC allows for visualization of the depressions present in the otherwise clear coating on a white surface

lost. The intensity of the effect can be adjusted which highlights the differences across the surface in refraction and optical depth and height.

The PLM technique allows us to quickly get a view of the surface topography with little sample preparation. Standard optical microscopy using a reflective light source grants us the ability to see distinct features but little of the surface structure. With PLM and NIC we can gather novel information regarding the surface structure. While NIC microscopy gives us an idea of surface topography it is not the ideal method for measurement of depth, slope and height. The information gathered is an optical depth based on the level of polarization, and so optical index variations may impact an apparent depth measurement. Cross-sections are always recommended for the best results in depth or thickness profiling.

Surface examination by SEM imaging allows us to even more clearly see and measure the size of the features on the surface of the playing card. We will map and quantify by drawing measurable lines over the features to tell their exact size and dimensions. What once appeared random with the optical microscope becomes uniform when examining the card surface using the SEM.

For the next level of analysis of the card surface profile we will be using Scanning Electron Microscopy in our next installment of Anatomy of a Playing Card. Future installments will include cross section examination with elemental mapping as well as micro-FTIR examination.

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