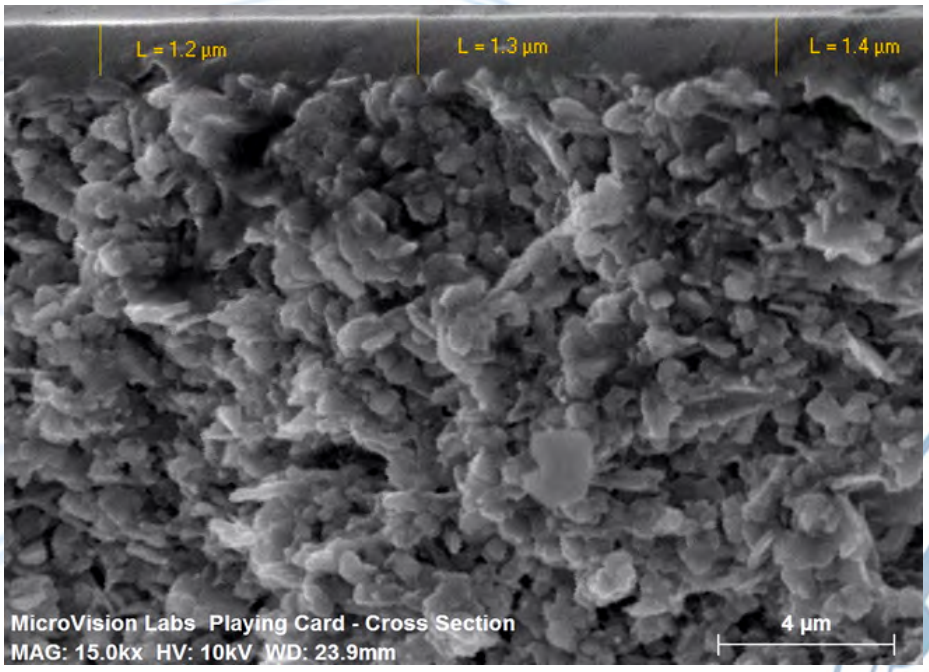
MICROVISION
LABORATORIES, INC.

The Anatomy of a Playing Card

(part 3 - Analysis of Stucture and Inorganics in Section)

In the previous edition of Anatomy of a Playing Card we illustrated how SEM imaging allow us to examine the surface of an object at very high magnification showing us details that may not have been previously visible using standard light optical microscopy. This time we are examining the card by cross section analysis so we can better understand the card construction from the inside out. Cross section analysis is done using special techniques freeze fracturing the card in half so we can examine the inner structure and elements that comprise the card below the surface.



In the previous chapter we showed how we could measure distinct features on the surface of the card. The same holds true for cross sectional analysis. With this particular card we can evaluate the thickness of the distinct coating layers. The very top surface which is measured on the sample above is the clear coating layer. Below the clear coating layer is the section of paper coating. The structure and morphology of the layer indicates that it is substantially thicker and made up of platelets and some round particles with something that flows over the surfaces possibly holding it all together. It also shows us that the clear coating layer at the top surface is smoother and more uniform with nothing that looks inorganic in origin.

Examination of the whole cross sectional layer of the card gives us a greater perspective of what the card is constructed.

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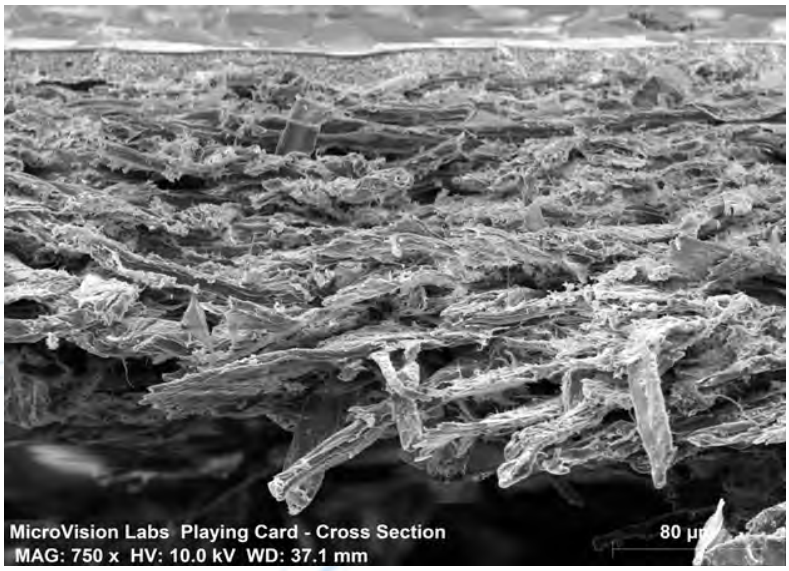
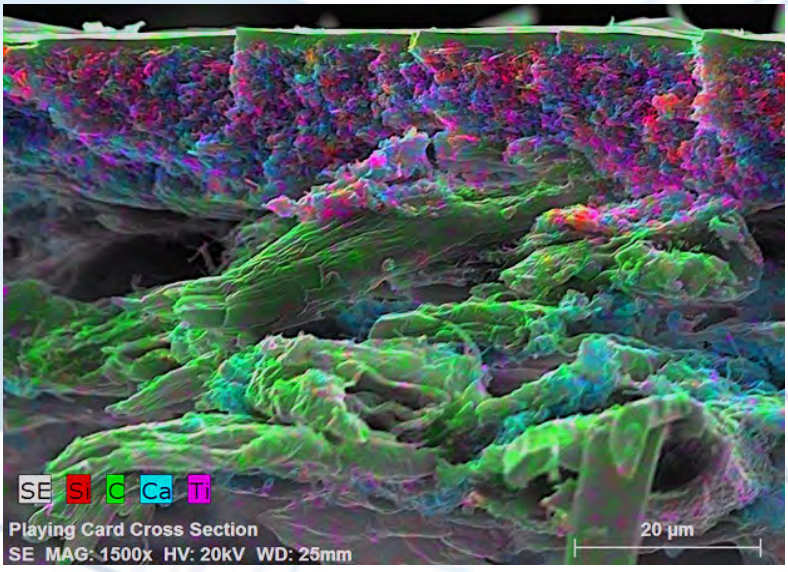
The thin top surface layer is the clear top coat layer, the surface below the paper coating and then cellulose fiber layer dwarfs both the other layers below that. Fiber content, orientation, and species analysis can be visually examined and relevant information regarding stiffness and strength could be inferred. We can also see the depth of penetration of the paper coating elements into the fiber layer. But how do we know what elements comprise the coating structure?



Elemental analysis is done by Elemental Dispersive X-ray Spectroscopy, EDS or EdaX for short. For our purposes we will refer to this analysis as EDS. In the microscope electron beams are shot at the sample in a high vacuum environment and when exposed to the beam they generate x-rays to due secondary electron transitions. The amount of energy and x-rays present is discrete for each element and the information is collected by the EDS. This allows us to be able to map out an area based on the elemental structure. The spatial resolution of this mapping is about half a micron. The software with the EDS gives us the ability to assign a color to each element so we can visually see what elements are where.



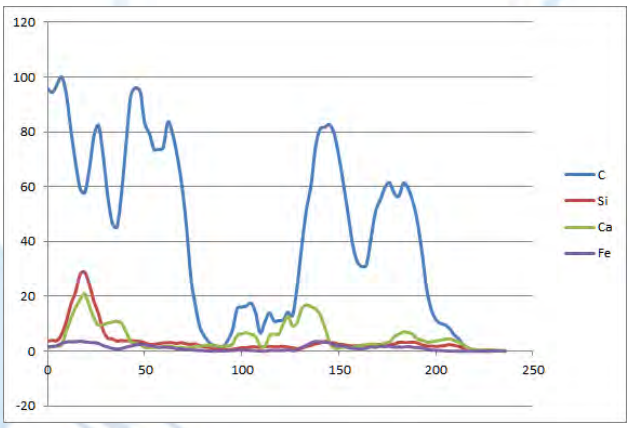
The different elements in the cross section are listed in the legend in the lower left hand corner of the image. Now we don't have to guess at what the materials are by their shape, size, and structure. Now we have quantifiable results. The map shows the clear coat layer is carbon based. The paper coating below is comprised of Clay and Calcium Carbonate, with some TiO2 as well with some carbon based material possibly holding the coating layer together. Since the Calcium Carbonate (small blue

particles) is smaller than the clay particles, more of it is dispersed into the fiber layer, similar to what might happen if you put rocks and sand into a glass, the sand settles to the bottom. At higher magnification we could potentially evaluate the level of ink penetration into the paper coating.

In the next edition we will go into further detail with the EDS and cross sectional analysis with line scanning for elements across the cross section and evaluating peaks. Next after that we will start evaluating the organic components of the card. Till next time here at MicroVision Labs!

Thanks,

Jeff Jacques



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