

Chemical State Mapping and Depth Profiling in a Scanning Auger Microprobe

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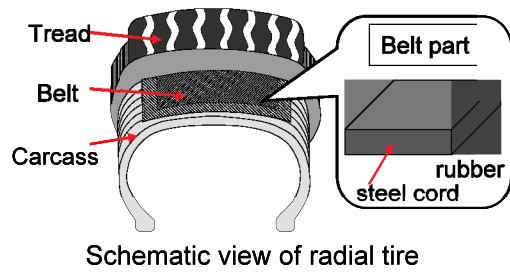
The Scanning Auger Microprobe (SAM) has long been considered the instrument of choice for high spatial and depth resolution microanalysis. Current models attain analytical volumes defined by less than 10nm wide by 6nm deep thus providing the most sensitive surface analysis. When it comes to electron spectroscopy it is generally agreed that X-ray Photoelectron Spectrometer (XPS) systems provide the golden standard. They provide similar depth resolution to SAMs but do not come close in spatial resolution; spot sizes of less than a few microns seem to be the limit.

The energy resolution of the photoelectron is inherently better than that of the Auger electron (based on the physics of signal generation), but if Auger electrons were collected using a high resolution spectrometer many benefits normally associated with XPS can be realized.

The JEOL JAMP-9500F is a SAM that utilizes such a high energy resolution ($\Delta E/E=0.05\%$) hemispherical analyzer (HSA). Comparing spectra obtained from an XPS to that of a SAM shows the peaks of the latter to be broader but similar in basic shape. It is the analysis of this shape that can yield very useful spectroscopic information at extremely high spatial resolutions. One very important piece of data that can be extracted is information revealing the chemical state of the compounds analyzed. Determination of the oxidation state or valence number of the species is vital to the understanding of exactly how surfaces are formed and predicting their chemical reactions relative to bonding and growth.

Chemical state information can be obtained and displayed in 1D (Auger depth profiling) or in 2D (Auger mapping). In both cases sub 10nm resolution can be realized in the JAMP 9500F. By peak share matching and peak deconvolution we can recalculate these maps and depth profiles into chemical state (or phase) maps and profiles.

This paper will present examples of both chemical state maps and depth profiles on real world samples where determining the valence state or oxidation state of the species in question solved the problem.



Analysis spot

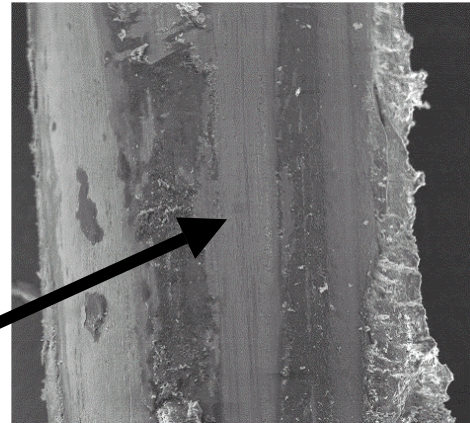


Fig. 1: A typical steel belted radial tire. The steel wires forming the belt are coated with brass to provide adhesion with the rubber. The rubber was stripped from the wire to test adhesion only to find poor bonding.

Fig. 2: An SEM image of the wire that shows light areas of poor bonding.

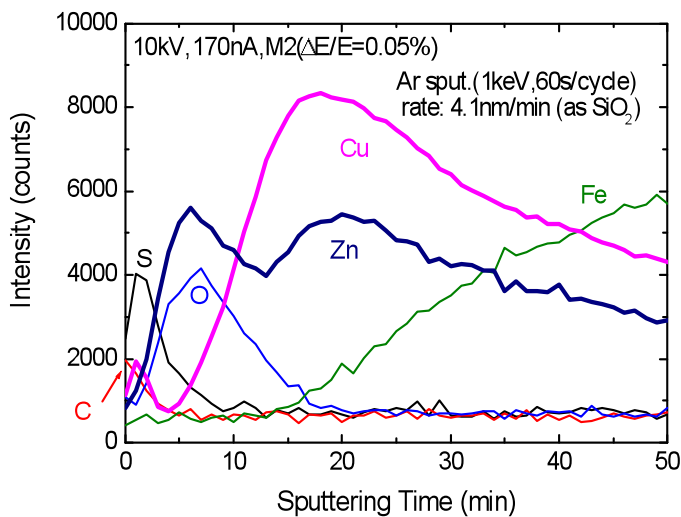


Fig. 3: Results of a depth profile on the bright area for O. S. Cu.

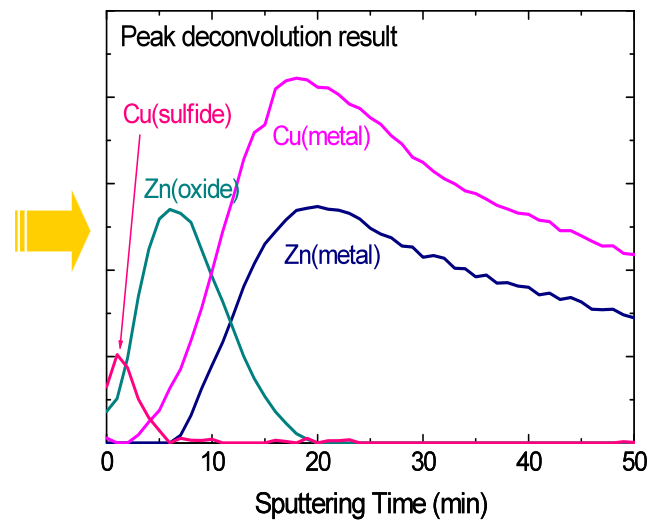


Fig. 4: Results of the peak shape deconvolution revealing a ZnO phase formed during manufacturing that resists bonding. Problem solved!