INDUSTRIAL PILOT PROJECT

InfraRed Imaging for Nano Characterization of Degradation Biobased Coil Coatings

THE INDUSTRIAL CHALLENGE

Coil coatings are highly durable organic coatings used for exterior architecture or other outdoor applications such as roofing, rainwater systems and facades. Recent years, efforts have been done to produce coil coatings with reduced environmental impact by replacing fossil based chemicals with biobased building blocks. If the durability is to be preserved, or preferably improved, it is important to study coating degradation mechanisms for biobased coating formulations.

WHY USING A LARGE SCALE FACILITY

To get a better understanding of this, and to be able to study chemical changes in the coating related to hydrolysis and photo-oxidation requires local analysis with nanoscale lateral resolution. Laboratory FTIR-microscopy can provide chemical information about coating degradation, but its spatial resolution is limited to the micrometric length scale. In contrast, recently developed nanoscale IR-spectroscopical techniques (Nano-IR) such as scattering scanning near field optical microscopy (sSNOM) provides submicron or nanoscale lateral resolution. sSNOM can utilize both laboratory laser and synchrotron light sources. While laser sources suffer from cut-offs at essential wavenumbers, with difficulties to detect some IR-band, the synchrotron radiation bandwidth is advantageous as it spans the entire mid-infrared region and also is stable and continuous. However, its lower spectral irradiance compared to many laser sources, may limit the applicability.

HOW THE WORK WAS DONE

Prior to analysis, 20-25 μm polyester melamine coil coatings with biobased reactive diluents were applied on zinc coated steel and exposed to both accelerated weathering tests and field exposures. A matrix of 18 different samples were studied and the degradation of coating was followed by determining the decrease of an IR band for the melamine crosslinker. Analysis of the surfaces were performed without further sample preparation while cross section were made with broad ion beam milling The experiments were made at the SMIS 1 beamline at Soleil, Paris. Micron sized areas on nine surfaces and nine cross sections were analysed using synchrotron light for spectroscopic measurements and a laser source for IR-imaging. To compare additional optical photothermal infrared (O-PTIR) microscopy was performed on cross sections using a laser source. Assistance by beamline scientists Christophe Sandt and Ferenc Borondics is appreciated.

Figure 1. sSNOM instrument (Nano IR) at the SMIS 1 beamline at Soleil.

THE RESULTS AND EXPECTED IMPACT

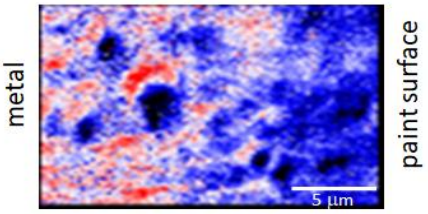

Figure 2. Nano IR-image of melamine band intensity showing a gradient over a 20 micron thick cross section dueto degradation of the coil coating

Information on degradation could be obtained through chemical imaging with both sSNOM and O-PTIR using the laser sources. However, due to relatively low signal to noise ratios with synchrotron light obtained on these thick industrial organic coatings, all Nano-IR spectroscopical measurements performed with the synchrotron light source provided little information on the degradation at nano-level. For these sample it was concluded that the performance of the synchrotron based Nano IR was presently insufficient and further development of the experimental set-up is required.

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