Using FT-IR Microspectroscopy for the Identification of Contaminants in Engineered Plastics

Engineered plastic components are ubiquitous in modern society. Plastics have the advantage of lowering cost, reducing parts count and weight, and providing ultimate industrial design flexibility as complicated functional shapes can be easily produced. Engineered plastic components can be filled or reinforced with carbon or other fibers to increase rigidity and strength.

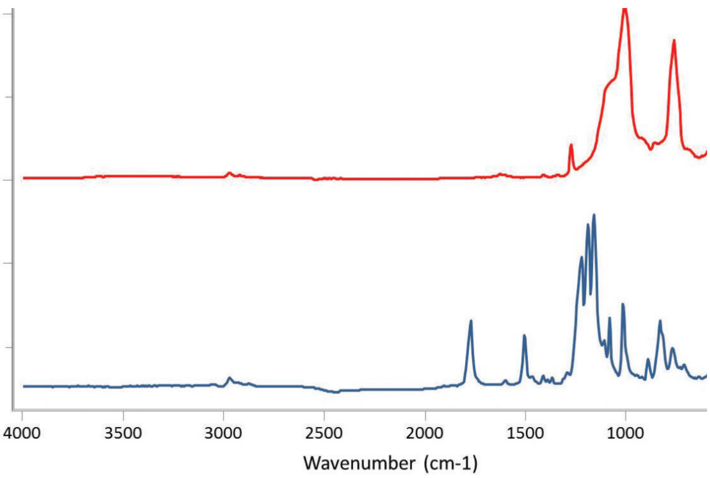

Figure 1: IR spectra of plastics material. Top: sample 1 - polydimethylsiloxane. Bottom: sample 2 - poly(bisphenol-A) carbonate

The analysis of contaminants in engineered plastics is important for aesthetics or functional acceptance. Timely identification of contaminants can increase the production yield and quality of the components. In this note, we demonstrate the FT-IR microanalysis of visible contaminants in injection molded plastic components.

A contaminant in fine paper is shown in the digital image in Fig.1, recorded through the diamond ATR prism on SurveyIR using oblique (dark field) illumination. The contaminant appears as a black particle in the upper left section of the image. Discontinuity in the surface of the paper is also noted. It is likely that a larger contamination particle was transferred during the manufacturing process, possibly on the calendar rollers. A similar particle was excised from the paper and placed on a low E glass slide (Fig. 2.) for analysis. The particle was flattened using a stainless steel roller and reflection-absorption spectra were recorded from the low E glass substrate. IR spectra of the particle are shown in Fig. 3. These spectra were measured with a 250 μm aperture using two detector spectrometer-mounted configurations – a narrow-band mercury-cadmium-telluride (MCTA) and deuterated

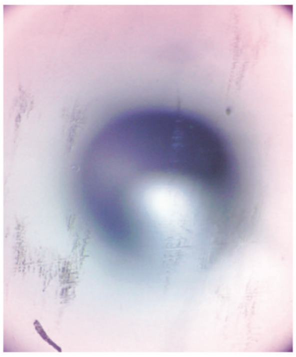

Figure 2: Digital micrograph of contaminant – sample #1

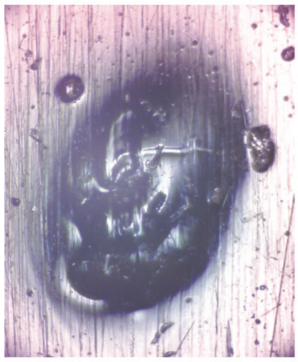

Figure 3: Digital micrograph of contaminant – sample #2

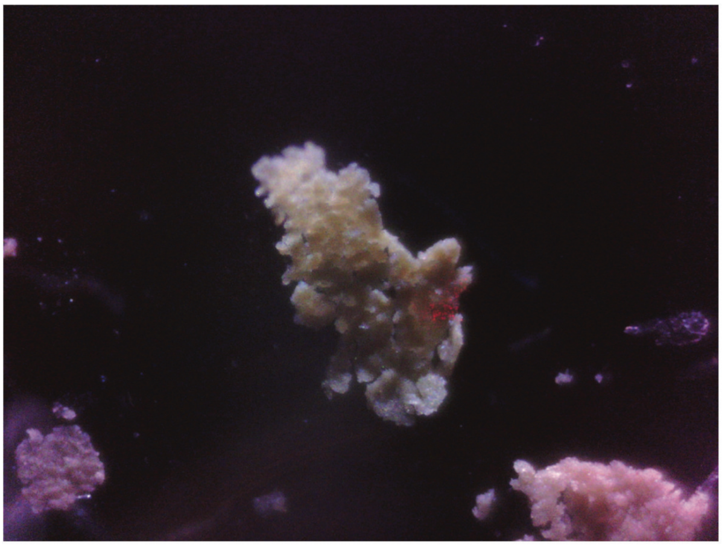

Figure 4: Digital micrograph of excised contaminant

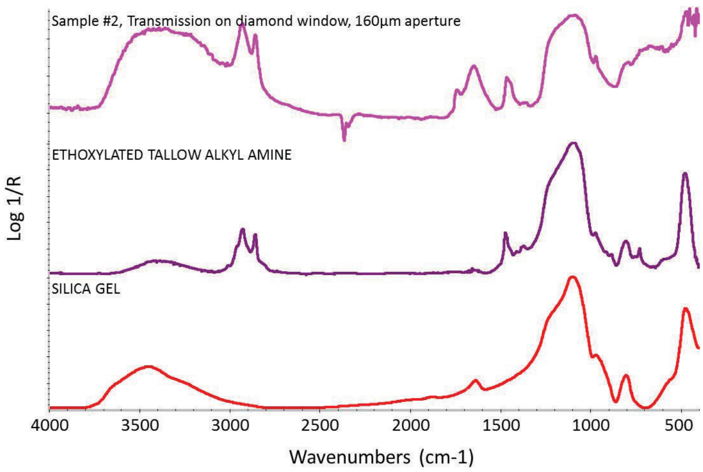

Figure 5: Micro-contaminant analysis results for sample #2 – poly (bisphenol-A) carbonate. Top: IR spectrum of contaminant. Middle: IR spectrum of spectral search candidate – ethoxylated tallow alkyl amine. Bottom: IR spectrum of silica gel.

A digital image of an excised contaminant is shown in Fig. 4. This image was recorded with dark-field illumination. Under the microscope, the contaminant appears as an oily-particulate consistence. IR spectra were recorded from contaminants excised from both plastic materials. Fig. 5 illustrates an analysis result from sample #2. A contaminant particle was thinned by rolling onto a KBr window substrate. The IR spectrum of the contaminant is shown at the top of Fig. 5. Spectral match candidates are shown in the middle and bottom of the figure. Clearly a predominant component of the contamination is silica ($SiO2$) and very good correspondence is noted between the contaminant and silica gel, a very common synthetic silicate. Silica is not the only component however. Some similarity is noted to the material ethoxylated tallow alkyl amine, which also contains a heavy silica loading. The plastic contaminant exhibits absorption bands at 2924, 2850, 1458, and 1377 cm-1 due to C-H vibrations characteristic of long chain hydrocarbons. Additionally, a carbonyl band is observed at 1732 cm-1 in the ester absorption range. The most probable explanation is that the contaminant is a mixture of silica and natural product oil, such as castor oil or linseed oil. Silica has numerous applications in plastics manufacture including use as filler and a mixing, anti-caking aid. The analysis of the contaminant from sample #1 yielded the same identification.

This brief note illustrates the ease in which micro-contaminants in plastics can be observed, recorded, and identified using the SurveyIR microanalysis accessory.