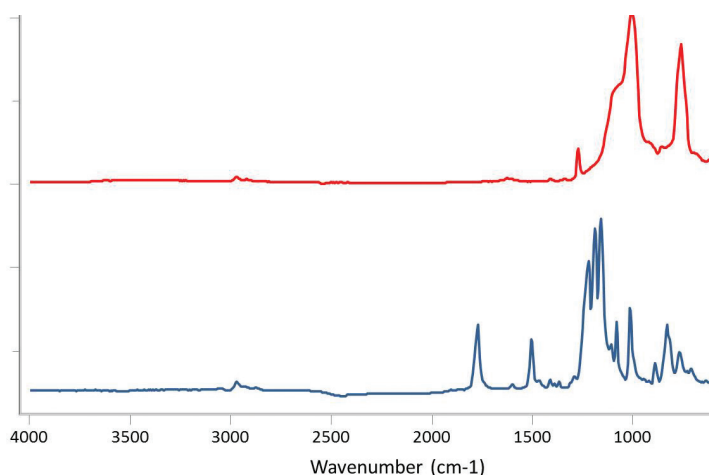


# Using FT-IR Microspectroscopy for the Identification of Contaminants in Engineered Plastics

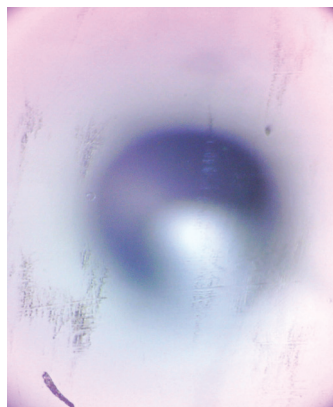
Engineered plastic components are ubiquitous in modern society. Plastics have the advantage of lowering cost, reducing parts count and weight, and providing ultimate industrial design flexibility as complicated functional shapes can be easily produced. Engineered plastic components can be filled or reinforced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



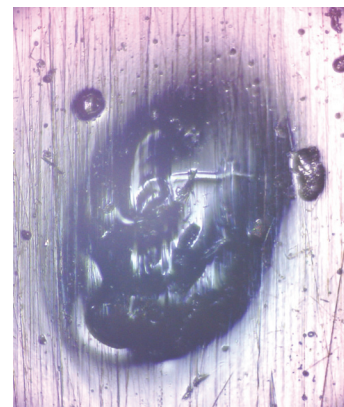
**Figure 1:** IR spectra of plastics material. Top: sample 1 - polydimethylsiloxane. Bottom: sample 2 - poly(bisphenol-A) carbonate

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.

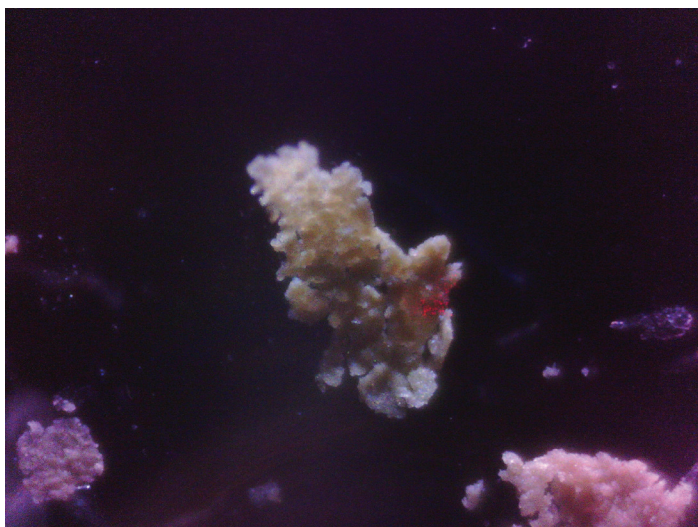
All data in this work was recorded using a SurveyIR FT-IR microanalysis accessory interfaced to a laboratory FT-IR spectrometer and utilizing the spectrometer mounted DTGS detector. The plastic components were produced by an injection molding process. Microscopic blemishes were visible on the exterior of the parts. The components were pigmented black. Two components were investigated. Infrared (IR) spectra were measured from the material, away from the blemish area. These spectra, measured on SurveyIR in ATR mode with a 250 $\mu$ m aperture, are shown in Fig. 1. Sample #1 is composed of polydimethylsiloxane and sample #2 is composed of poly (bisphenol-A) carbonate. Captured video microscopy images of the two representative blemishes are shown in Figs. 2 and 3. These digital images were recorded using the integrated camera on SurveyIR and using reflected light illumination. Attempts to measure the IR spectra of the contaminants *in situ* were unsuccessful as the contamination was sub-surface. Contamination particles were relative easy to excise from the plastic parts.



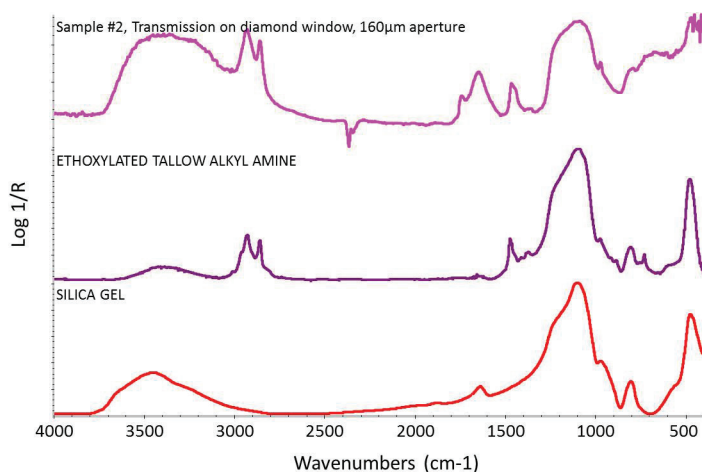
**Figure 2:** Digital micrograph of contaminant – sample #1



**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 consistency. 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 ( $\text{SiO}_2$ ) 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  $\text{cm}^{-1}$  due to C-H vibrations characteristic of long chain hydrocarbons. Additionally, a carbonyl band is observed at 1732  $\text{cm}^{-1}$  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.