

Spectroscopy-FTIR/EDX

A summary of Shimadzu Application No. SCA\_110\_104

Polymer in black and white Analysis of coffee mug lids with FTIR single reflection ATR and EDX surface analysis.

**-Black or white coffee we know, but what makes the lids black or white?**



Figure 1: Coffee cups with lids of different color

Disposable plastic is a hot topic. Here Shimadzu has analyzed a product designed to contain heat – Coffee cup lids. Both lids display the symbol of recyclable Poly Styrene but have different colors. The question is what makes one appear white and the other black?

Analysis by the non-destructive techniques FTIR and EDX can answer that.

FTIR analysis-library search confirmed that the plastic indeed was PS. But what about the color?

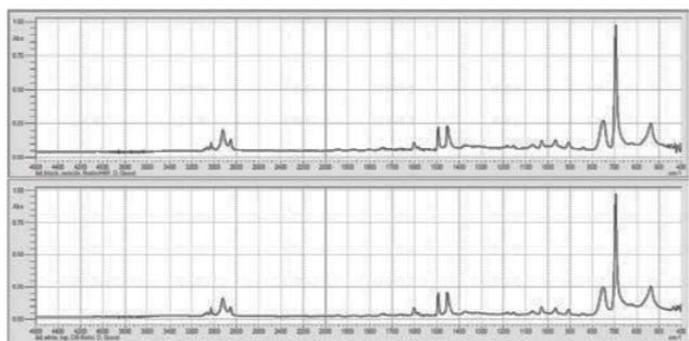


Figure 2: FTIR spectra from two different polymer lids made from PS, upper is the spectrum from a black (offset 50 mAbs) and the lower from a white lid (offset 10 mAbs).

The baseline drift in the spectrum from the white lid in the range from 800 to 400 cm<sup>-1</sup> shows the influence from a white standard. Such drift is often related to TiO<sub>2</sub>. The black color can be carbon black. Carbon black is not infrared active, though can however cause an offset of the baseline like the one seen here.

This application also used X-ray fluorescence to find the element distribution. The polymer concentration was naturally high for both lids. Results are presented in table 1 and 2.

Quantitative Result					
Analyte	Result	Std.Dev.	Calc.Proc	Line	Intensity
Ti	3.499 %	[ 0.008]	Quan-FP	TiKa	237.4913
Ca	0.263 %	[ 0.002]	Quan-FP	CaKa	3.0367
Al	0.178 %	[ 0.036]	Quan-FP	AlKa	0.0197
Si	0.101 %	[ 0.012]	Quan-FP	SiKa	0.0436
P	0.024 %	[ 0.005]	Quan-FP	P Ka	0.0269
Zn	0.023 %	[ 0.001]	Quan-FP	ZnKa	6.4420
S	0.022 %	[ 0.003]	Quan-FP	S Ka	0.0682
Cu	0.014 %	[ 0.001]	Quan-FP	CuKa	3.3454
Fe	0.009 %	[ 0.001]	Quan-FP	FeKa	1.3622
Tm	0.005 %	[ 0.002]	Quan-FP	TmLa	0.2982
Ni	0.004 %	[ 0.001]	Quan-FP	NiKa	0.8050
Plastic	95.860 %	[-----]	Balance	-----	-----

Table 1: White lid EDX results

Quantitative Result					
Analyte	Result	Std.Dev.	Calc.Proc	Line	Intensity
Al	0.060 %	[ 0.015]	Quan-FP	AlKa	0.0089
S	0.022 %	[ 0.001]	Quan-FP	S Ka	0.0977
Ca	0.011 %	[ 0.001]	Quan-FP	CaKa	0.1910
Ho	0.011 %	[ 0.001]	Quan-FP	HoLa	1.1878
K	0.008 %	[ 0.001]	Quan-FP	K Ka	0.0823
Cu	0.008 %	[ 0.000]	Quan-FP	CuKa	3.5214
Fe	0.003 %	[ 0.000]	Quan-FP	FeKa	1.0265
Co	0.003 %	[ 0.000]	Quan-FP	CoKa	1.0287
Zn	0.001 %	[ 0.000]	Quan-FP	ZnKa	0.5916
Ni	0.001 %	[ 0.000]	Quan-FP	NiKa	0.2181
Plastic	99.872 %	[-----]	Balance	-----	-----

Table 2: Black lid EDX results

Titanium (3.5%) and small amount of Ca (0.26%) was found in the white lid. The black lid had no significant concentrations in the element distribution.

**Conclusion**

The black lid is PS in combination with carbon black which gives a black color.

The white lid is PS in a mixture with TiO<sub>2</sub> (Titan dioxide). TiO<sub>2</sub> is the most used white standard in the industry for food packaging and cosmetics. In addition, Calcium was detected. Which indicates CaCO<sub>3</sub>, also a common white standard.

**Instrumentation**

FTIR: Shimadzu IRSpirit-T in combination with QATR-S.

EDX: Shimadzu EDX-8000. Neither of the techniques require any sample preparation.