Application Note: 41671

Analysis of TFT Glass

Thermo Scientific ARL PERFORM'X Series Advanced X-Ray Fluorescence Spectrometers

Key Words

- ARL PERFORM'X 4200 W
- TFT Glass
- X-ray fluorescence
- XRF

Introduction

TFT glass is a thin layer glass specially designed for the LCD market used in applications such as laptop displays, monitors, handheld devices and navigation systems.

These displays are normally 0.3 to 0.7 mm in thickness and are equipped to withstand high temperature without being transformed in nature. The resulting substrates are alkaline-free and resistant against chemical agents and heat.

Instrument

Thermo Scientific ARL PERFORM'X series spectrometer used in this analysis was a 4200 watt system. This system is configured with 6 primary beam filters, 4 collimators, up to nine crystals, two detectors, helium purge and our 5GN+ Rh X-ray tube for best performance from ultra-light to heaviest elements thanks to its 50 micron Be window. This new X-ray tube fitted with a low current filament ensures an unequalled analytical stability month after month.

The ARL PERFORM'X offers the ultimate in performance and sample analysis safety. Its unique LoadSafe design includes a series of features that prevent any trouble during sample pumping and loading. Liquid cassette recognition prevents any liquid sample to be exposed to vacuum by mistake. Over exposure safety automatically ejects a liquid sample if X-ray exposure time is too long.

The Secutainer system protects the primary chamber by vacuum collecting any loose powders in a specially designed container, easily removed and cleaned by any operator. For spectral chamber protection, the ARL PERFORM'X uses a helium shutter designed for absolute protection of your goniometer during liquid analysis under helium operation. In the "LoadSafe Ultra" optional configuration, a special X-ray tube shield provides total protection against sample breakage or liquid cell rupture.

Results

A series of flat glass standard samples have been measured on the ARL PERFORM'X. Calibration curves have been derived by relating intensities for each oxide (or element) to concentrations in the standard samples. X-ray fluorescence measures elements, but the results can be related directly to the oxide forms of these elements when only one single form is present in the sample. Using the calibration curves, limits of detection have been derived for the most common oxides found in flat glasses (Table 1).

OXIDE/ ELEMENT	LINE	CRYSTAL	DETECTOR	LOD PPM
Na_2O	Kα	AX06	FPC	N.R.
MgO	Kα	AX06	FPC	9.2
Al_2O_3	Kα	PET	FPC	2.4
SiO_2	Kα	PET	FPC	N.R.
Cl	Kα	PET	FPC	2.7
SO_3	Kα	PET	FPC	0.8
K_2O	Kα	LiF 200	FPC	1.2
CaO	Kα	LiF 200	FPC	N.R.
TiO_2	Kα	LiF 200	FPC	0.7
Fe_2O_3	Kα	LiF 200	FPC	1.0
As_2O_3	Kα*	LiF 200	SC	0.4
SrO	Kα	LiF 200	SC	0.9
Co_2O_3	Kα	LiF 200	FPC	0.8
B	Kα	AXBeB	FPC	0.06%

Table 1: Analytical parameters and limits of detection for various oxides/element in flat glass (100 sec. counting time)

N.R. = LoD is not relevant for major elements

FPC = flow proportional counter

SC = scintillation counter

Excitation conditions: 50 kV / 70 mA except for B: 30 kV / 100 mA

*: no Pb in samples, thus no spectral overlap

Precision tests have been carried out by running samples for ten repeat analyses. The results are summarized below:

	NA2O %	MGO %	AL2O3 %	SIO2 %	SO3 %	K2O %	CAO %	FE2O3 PPM
TIME [S]	10	10	10	10	10	10	10	10
Run 1	11.35	0.245	2.78	69.97	0.214	1.91	9.97	369
Run 2	11.34	0.250	2.77	69.93	0.213	1.90	9.97	372
Run 3	11.36	0.250	2.77	69.97	0.211	1.91	9.96	373
Run 4	11.35	0.251	2.78	69.93	0.211	1.91	9.98	377
Run 5	11.33	0.252	2.77	69.95	0.210	1.91	9.97	376
Run 6	11.33	0.251	2.77	69.93	0.213	1.90	9.99	370
Run 7	11.35	0.252	2.78	70.00	0.211	1.91	9.97	372
Run 8	11.36	0.249	2.77	69.96	0.214	1.91	9.96	375
Run 9	11.35	0.252	2.78	69.95	0.210	1.91	9.97	374
Run 10	11.35	0.250	2.77	69.99	0.211	1.91	9.98	377
Avg.	11.35	0.250	2.77	69.96	0.212	1.91	9.97	374
Std.Dev.	0.012	0.0023	0.005	0.029	0.002	0.004	0.009	3

Table 2: Repeatability for the analysis of the main oxides in a flat glass (10s counting time i.e. 80s total counting time)

	NA2O %	MGO %	AL2O3 %	SIO2 %	SO3 %	CL PPM	K2O PPM	CAO %	TIO2 %	FE2O3 PPM
TIME [S]	20	6	20	20	6	6	6	6	6	20
Run 1	13.75	4.13	0.580	71.33	0.388	117	128	9.61	0.017	145
Run 2	13.76	4.15	0.578	71.32	0.390	119	132	9.62	0.017	146
Run 3	13.76	4.15	0.575	71.31	0.391	115	133	9.62	0.016	148
Run 4	13.77	4.16	0.579	71.32	0.390	115	130	9.62	0.017	146
Run 5	13.77	4.15	0.579	71.34	0.388	120	136	9.62	0.017	146
Run 6	13.77	4.15	0.576	71.32	0.389	116	132	9.62	0.017	147
Run 7	13.76	4.15	0.578	71.32	0.385	114	131	9.62	0.016	147
Run 8	13.76	4.15	0.578	71.33	0.388	114	132	9.61	0.017	145
Run 9	13.76	4.15	0.580	71.32	0.386	121	129	9.62	0.018	145
Run 10	13.75	4.14	0.577	71.33	0.383	118	133	9.62	0.017	146
Avg.	13.76	4.15	0.578	71.32	0.388	117	132	9.62	0.017	146
Std.Dev.	0.009	0.01	0.002	0.007	0.002	2.4	2.4	0.004	0.0005	1

Table 3: Repeatability for the analysis of the main oxides in a flat glass (various counting times as shown, i.e. 116s total counting time)

	B2O3	B2O3 (AS B2)
Run 1	5.92	1.83
Run 2	6.01	1.86
Run 3	5.99	1.85
Run 4	6.07	1.87
Run 5	6.03	1.86
Run 6	6.10	1.88
Run 7	6.12	1.89
Run 8	6.06	1.87
Run 9	6.08	1.87
Run 10	6.09	1.88
Average	6.05	1.87
Std.Dev.	0.06	0.02

Table 4: Repeatability for boron analysis in glass at (120 s - 30 kV / 140 mA)

Conclusion

Limits of detection at the 1 ppm level for metallic oxides in glasses are possible with the ARL PERFORM'X instrument. Even with short counting times very good short term stability is achieved. These results show that the ARL PERFORM'X spectrometer is well suited to produce high precision results for the determination of the main oxides and the coloring agents in glasses.

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