Application Note EDXRF1472

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EDXRF1472 - Analysis Of Glass & Raw Materials

Scope

The analysis of glass and raw materials is demonstrated in the manufacturing of soda-lime glass.

Background

Soda-lime glass makes up 90% of the global glass production and is used to make windows, glassware and bottles. Common raw materials include sodium carbonate (soda), calcium carbonate (limestone), calcium oxide (lime), dolomite, alumina, slags and sand (SiO_2). Raw materials must be screened and mixed properly to give the desired glass properties for the finished products. Metal oxides such as CrO_3 and Fe_2O_3 impart color to the glass, and so must also be closely monitored during production. Final glass composition is then monitored to ensure the highest quality product. Rigaku NEX CG meets these measurements needs in a simple to use benchtop system, ideally designed for the at-line non-technical QC technician and the advanced technical user alike.

Model: NEX CG

NEX CG results: Finished glass

Glass disk samples were provided by a manufacturing site for analysis. Values were obtained by 4 kW WDXRF as assays. Fundamental Parameters (FP) was used to model the spectra and elemental composition. FP results were optimized using a Matching Library consisting of two assayed samples.

Production Glass Disk #93 **Units: mass%**			
Component	**WDXRF value**	**NEX CG result**	**Statistical error**
Na_2O	13.74	13.88	0.16
MgO	4.01	3.99	0.05
Al_2O_3	0.14	(0.12)	0.02
SiO_2	72.85	72.86	---
SO_3	0.184	0.182	0.003
Cl	0.006	0.007	0.0002
K_2O	0.042	0.042	0.003
CaO	8.90	8.87	0.02
TiO_2	0.017	0.014	0.001
Cr_2O_3	0.0003	ND	---
MnO_2	0.0013	(0.0008)	0.0002
Fe_2O_3	0.0663	0.0620	0.0019
SrO	0.006	0.007	0.0002
ZrO_2	0.006	0.009	0.0005

ND = Not Detected ( ) = Below Lower Limit of Quantification

Production Glass Disk #23 Units: mass%			
Component	**WDXRF value**	**NEX CG result**	**Statistical error**
Na_2O	13.77	13.79	0.17
MgO	3.88	3.91	0.05
Al_2O_3	0.05	ND	---
SiO_2	72.73	72.76	---
SO_3	0.205	0.199	0.003
Cl	0.008	0.007	0.0003
K_2O	0.007	(0.008)	0.002
CaO	9.23	9.17	0.02
TiO_2	0.009	0.011	0.0006
Cr_2O_3	0.0003	ND	---
MnO_2	0.0009	(0.0006)	0.0002
Fe_2O_3	0.0119	0.0116	0.0009
SrO	0.005	0.005	0.0002
ZrO_2	0.006	0.008	0.0005

ND = Not Detected ( ) = Below Lower Limit of Quantification

NEX CG results: Raw materials

Raw materials were measured as hydraulically pressed pellets using Rigaku Scattering FP for screening purposes. To enhance FP performance it is recommended to create a Matching Library.

Sand Units: mass%		
Component	**RPF-SQX result**	**Statistical error**
Al_2O_3	0.054	0.0045
SiO_2	96.57	0.0867
K_2O	0.131	0.0083
CaO	0.033	0.0038
TiO_2	0.018	0.0007
Cr_2O_3	0.0073	0.0005
Fe_2O_3	0.037	0.0009

Co_2O_3	0.0008	0.0004
CuO	0.0017	0.0001
SrO	0.0017	0.0001

Soda Ash **Units: mass%**		
Component	**RPF-SQX result**	**Statistical error**
Na_2O	64.63	0.0971
Al_{23}	0.017	0.0007
SiO_2	0.091	0.0005
SO_3	0.022	0.0004
K_2O	0.0041	0.0024
CaO	0.016	0.001
Cr_2O_3	0.0001	0.0002
Fe_2O_3	0.0028	0.0003
CuO	0.0011	0.0001

Dolomite **Units: mass%**		
Component	**RPF-SQX result**	**Statistical error**
MgO	18.19	0.0430
Al	0.0775	0.0013
SiO_2	0.314	0.0025
S	0.0106	0.0002
Cl	0.0033	0.0001
CaO	36.61	0.0390
Ti	0.0020	0.0003
Cr	0.0003	0.0001
Mn	0.0025	0.0003
Fe	0.0174	0.0004
Cu	0.0010	0.0001
Zn	0.0005	0.0001

Sr	0.0137	0.0001

Lime **Units: mass%**		
Component	**RPF-SQX result**	**Statistical error**
MgO	0.869	0.0078
Al_2O_3	0.685	0.0029
SiO_2	2.02	0.0053
SO_3	0.236	0.0008
K_2O	0.161	0.0078
CaO	61.64	0.0869
TiO_2	0.027	0.0031
Cr_2O_3	0.0020	0.0012
MnO	0.044	0.0014
Fe_2O_3	0.337	0.0026
Co_2O_3	0.0047	0.0008
CuO	0.0032	0.0002
SrO	0.017	0.0001

Fundamental parameters

Rigaku RPF-SQX Fundamental Parameters (FP) and Scattering FP

The Rigaku RPF-SQX software automatically deconvolutes spectral peaks and models the sample matrix and X-ray absorption/enhancement effects using fundamental XRF equations. The versatile RPF-SQX software is simple to use and offers many ways to craft a matrix model based on the specific glass or raw material composition. This allows for semi-quantitative analysis without the use of any reference standards, typically returning concentration results on the order of 15-20% relative.

Scattering FP is the Rigaku technique of using the measurement of the Compton and Thomson (Rayleigh) scatter peaks to gain valuable information about the sample matrix. By comparing the Compton and Thomson scatter peaks, the average atomic number of the sample is calculated and from this the percentage of the sample that cannot be measured (elements H - F) is estimated, improving the quantification of the elements Na – U. Use of Scattering FP is ideal for the analysis of raw materials where the composition of the unmeasureable balance of the sample can change significantly from sample to sample.

Matching library

The semi-quantitative measurements using RPF-SQX can be further optimized with the use of a Matching Library. A Matching Library is easily created by the operator using the measurements of one or more assayed reference samples of the material type. The measurements of these “type standards” are registered in a library specific for the particular material composition of interest and give the FP theoretical equations examples of the actual matrix. Depending on the number of type standards and how closely the type standards resemble the material composition of interest, use of a Matching Library can typically improve accuracy to approximately 5-10% relative.

Conclusion

The Rigaku NEX CG yields excellent performance for the elemental analysis of raw materials and final characterization of finished glass. If desired, FP semi-quantification can be improved with Matching Libraries based on one or more assayed type standards of the particular material type, as shown in the glass analyses. The NEX CG software is powerful and flexible, yet simple and intuitive to operate. These features make the NEX CG an ideal EDXRF tool for screening and characterization of glass and raw materials at the production line for optimum product QA/QC, in the quality laboratory and in R&D.