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APPLICATION NOTE

1: DISCRIMINATING GLASSES WITH ECCO

ECCO
Elemental Composition
Comparator

Glass Fragment

GRIM 3
Glass Refractive Index System

One of the most widely applied techniques for the forensic analysis of glass involves the measurement of its refractive index (RI) using the oil immersion method. The Foster + Freeman Glass Refractive Index Measurement (GRIM) system is a compact and convenient instrument intended for this purpose.

Improvements in glass manufacturing processes over the last 30 years have, however, caused the variation in RI to be significantly less than before and it is now often necessary to subject glass evidence to additional examination by elemental analysis.

In this Application Note, we demonstrate the potential of the Foster + Freeman Elemental Composition Comparator (ECCO) to differentiate between glass samples which cannot be distinguished by a measurement of RI alone.

The ECCO relies on the technique of Laser Induced Breakdown Spectroscopy (LIBS) and involves the generation of optical emission spectra from the target material that are characteristic of its elemental composition.

Glass samples

The study reported here involved subjecting 24 glass samples to analysis using GRIM 3 and ECCO. Each of the samples was obtained from the side window of a different make and model of vehicle. Such types of glass are expected to exhibit only a limited variation in RI.

GRIM 3: RI Discrimination 96%

No.	Vehicle	RI	No.	Vehicle	RI	No.	Vehicle	RI
1	Peugeot 405	1.52252(4)	9	Citroen Saxo	1.52049(3)	17	Mazda 323	1.51948(1)
2	Ford Escort	1.51637(5)	10	Maestro	1.51603(6)	18	BMW 316	1.51980(5)
3	Hyundai Accent	1.52175(2)	11	Daewoo Leganza	1.51800(2)	19	Range Rover	1.51936(1)
4	Vauxhall Astra	1.51955(1)	12	VW Polo	1.51916(1)	20	Isuzu Trooper	1.51933(6)
5	Peugeot 205	1.52068(1)	13	Ford Scorpio	1.52050(4)	21	Vauxhall Vectra	1.51976(1)
6	Peugeot 405	1.52372(2)	14	BMW 318	1.51974(2)	22	Renault Clio	1.52139(5)
7	Rover 216	1.51922(4)	15	Nissan Almeira	1.51902(1)	23	Rover 216	1.51909(2)
8	VW Golf	1.52079(2)	16	Volvo 440	1.51633(1)	24	Peugeot 306	1.52360(3)

RI measurements using GRIM 3
(Values in parentheses represent one standard deviation in the last digit).

Based on the above measurements, any pair of glass samples was regarded as "indistinguishable" if the values of RI differed by no more than 3 standard deviations. From a total of 276 pairs, 265 pairs could, and 11 pairs could not, be discriminated in this way, a discrimination rate of ~ 96%.

ECCO: Elemental Composition Discrimination 92%

Elemental concentration ratios	
Trace element	Principal element (Internal Standard)
Iron	Silicon
Aluminium	
Magnesium	Calcium
Strontium	
Barium	

ECCO provides the user with a spectral "fingerprint" of the elemental composition of the target material, in this case glass. The heights of the characteristic peaks in the ECCO spectrum are a measure of the concentration of the corresponding elements contained in the material. Principal elements (calcium and silicon) produce prominent emission lines whilst weaker lines occur from trace constituents, notably iron, aluminium, magnesium, strontium and barium. For comparative purposes it is convenient to determine elemental concentration ratios for these trace elements using the principal elements, silicon and calcium, as internal standards.

To effect the comparison, pairs of glass samples were regarded as "indistinguishable" if the values of mean peak height ratio differed by no more than 3 standard deviations. From a total of 276 pairs, 254 pairs could, and 22 pairs could not, be discriminated in this way, a discrimination rate of ~ 92%.

ECCO + GRIM 3: Discrimination (99.6%)

				Total	%	Comparator
	ECCO		◄	254	92	ECCO
21	244	10	◄	275	99.6	ECCO + GRIM 3
	GRIM 3		◄	265	96	GRIM 3
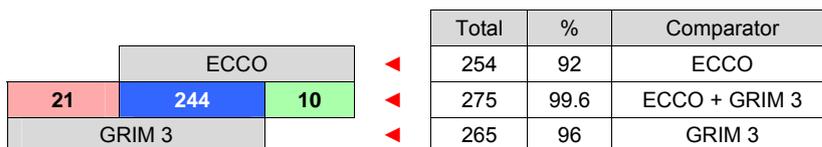
Of the 276 sample pairs, only 1 could not be distinguished either by GRIM 3 or ECCO examination, an overall discrimination rate of ~ 99.6% was therefore achieved in the study.

Conclusions

The ECCO provides a fast and effective method for improving the discriminating power of RI measurements obtained using GRIM 3. Unlike other elemental analysis techniques, the ECCO requires very little sample preparation. The instrumentation is cost effective, compact and almost free of maintenance.

Sales Support and Feedback

Foster + Freeman welcome feedback from Customers regarding this product. Please contact one of our offices if you would like to pass on your comments. Foster + Freeman are pleased to offer advice, installation, training and on-site maintenance worldwide for all of their products.

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