doi:10.1017/S1431927610058101
Microsc. Microanal. 16 (Suppl 2), 2010

Combined LIBS & Raman Spectroscopy for the Automated High Throughput Identification of Particles Larger 25µm for Industrial & Forensics Investigations.

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Sources of particulate contamination or micrometer sized trace evidence samples are often not easy to identify. One analytical method is often not enough, therefore technology using two independend spectroscopic systems on the same micrometer spot has been developed to increase the information available for immediate particle evaluation. The technology utilizes automated vibrational (Raman Spectroscopy) as well as elemental spectroscopy (Laser Induced Breakdown Spectroscopy, LIBS). Such cutting-edge technology can analyze any particle according to it's number, size, shape and chemical composition down to the micrometer.[1,2] Combined chemical/elemental structure information about hundreds to thousands of particles enables users to quickly locate contamination sources. The fully automated system is perfect for even non-microscopists.

The technology detects inorganic,organic, or metallic particles enabling problem solving. The customized integrated database enables users to compare analytical result data sets, detect trends, and implement the appropriate quality management systems.

Automated high throughput analyses detects particle quantity, shape, and size ranging from 5 µm and larger. Automated threshold binarization algorithms (Ref. Fig.1,) Raman Analysis, and LIBS (metal.ID) analyses detect particles ranging from 20µm and larger. Particles do not get lost because all analyses are performed in one run instead of other technique where particles are transferred.The system documents and stores all information in electronic records according to the CFR Part 11. Raw data including: images, spectra, target images (Ref. Fig. 2) and interpretation is stored and available for further analysis. The integrated report generator enables any user to prepare powerful reports in just a few minutes (Ref. Table 1.)

1. Valet, O. 2001. Where do particles come from? Clean Room Technology. *GIT-Verlag*.
2. Valet, O. 2001. Fast Material Analysis of Microparticles. Laboratory Magazine Laborzeitschrift. *GIT-Verlag*.
3. Lankers, M. 2002. Determining particle composition: Consider the path to the source. *CleanRooms* July.

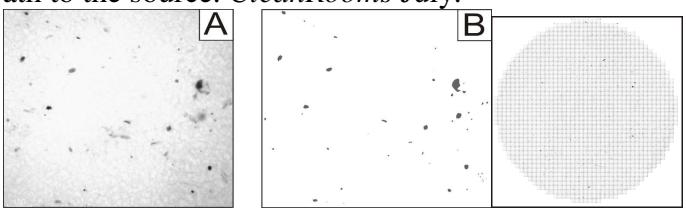

Figure 1. (B) A single field of view of particles located on the membrane after image recognition. Figure (B) is a view before image recognition. (C) Montage of 1764 individual fields of view to measure the entire 47 mm standard cellulose patch, within 20 minutes by the SPE instrument. Particles meeting a certain size criteria are preselected to undergo fully automated analysis to determine the automated Raman microprobe measurement.

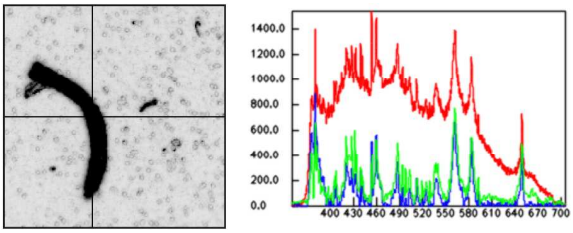

Figure 2. Particle ID, 204.2. Length: 161.8 µm. Class: 1, L/W: 2.4. Exp: 5.0 seconds. Result: Tin Alloy. Rank: 931, S/N: 32.4 (red=original spectra, blue=background corrected, green=database match)

Table 1: Automatically Generated Particle Size & Composition Distribution

Substance	**All**	**Size distribution (µm)**					
		25-50	**50–100**	**10–25**	**25–50**	**50–100**	**≥004**
Polystyrene	270	58	34	20	0	20	20
Polypropylene	154	29	2	56	0	59	4
Al-Si-Mg	59	146	22	12	34	7	7
High Alloy Steel 11% Cr.	26	17	7	9	21	10	0
Grey Rubber (Seal))	291	97	0	27	24	44	14
Analyzed	800	347	65	124	79	140	45
All particles	6516	2368	1976	459	846	660	207

https://doi.org/10.1017/S1431927610058101 Published online by Cambridge University Press