Application Note

ZEISS SmartPI

Automated Identification of Asbestos

Seeing beyond

ZEISS SmartPI

Automated Identification of Asbestos

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ZEISS Research Microscopy Solutions is the first to develop a fully automated asbestos identification system that incorporates an automatic asbestos fibre image identification and X-ray analysis using energy dispersive spectroscopy to validate that the fibre is asbestos.

The system is accurate and fast – a typical sample is fully analysed in under an hour (or under 30 minutes to stop at a statistically significant sample size). As the system is fully automated, it can run without any supervision and it does not get tired. The only human requirement is for a technician to load more samples.

All data are stored. Images, X-ray spectra and fibre positions can be reviewed at a later date. A supervisor can also review each fibre manually as another level of check to ascertain the validity of the results.

This is the first SEM-EDS system that is fully automated to detect asbestos. Currently, a UK asbestos analysis company has passed the UK Accreditation Service (UKAS) to detect asbestos using this new system.

Amosite and Chrysotile detected

History of Asbestos

Asbestos is a group of fibrous silicate mineral that is strong, cheap and resistant to chemical, heat, fire and electrical damage. These desirable properties are ideal in many engineering applications such as electrical and thermal insulation as well as fire and heat resistance. It can be mixed in with cements, paints, fabrics and bonds well with other materials. Therefore, asbestos containing materials became commonly used as building materials and other engineering components.

As early as the industrial revolution in the 1800s, asbestos was used in houses, buildings and ships. It was used in many materials such as asbestos cement, fire-retardant coating for steel girders, roofing and flooring compounds, thermal insulation, reinforcement for plasters and paints, automotive and airplane clutches, brake pads lining and insulation for electric wiring. In the UK, asbestos became very common as a building material in the 1950s and was used in the construction of almost all buildings from that period until it was banned in the 1980s and 1990s.

The ban on asbestos occurred because people who were involved in the mining, manufacture and installation of asbestos products often develop debilitating respiratory illness from inhalation of asbestos fibres that become trapped in the lungs. As the link between asbestos and debilitating lung diseases become stronger, some countries begin to legislate for full or partial bans on asbestos.

Identification of asbestos is normally done using light microscopy by dispersion staining methods. The fibres are suspended in liquids of known refractive index and rotated to observe the resulting colour in the microscope. This method is fast and sensitive for identification purposes. However, this method is labour intensive because it cannot be automated.

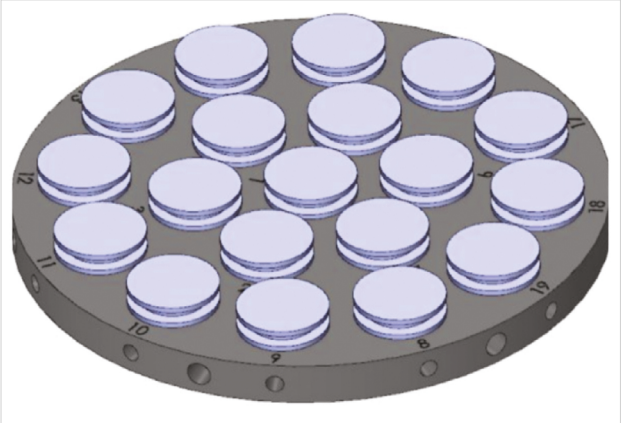


Figure 1 *Carl Zeiss 19 stub multi holder carousel*

Future of Asbestos identification

Scanning electron microscopes (SEM) can be an alternative method for identification of asbestos. The microscope can be automated to collect images, identify potential asbestos fibres and using X-ray energy dispersive spectroscopy (EDS), and identify the chemical composition of the fibre. The strongest justification of using a SEM-EDS is that this process can be automated.

Hitherto, this method has not been used to automatically identify asbestos collected from buildings because the samples are normally heavily contaminated by other material such as brick, cement, dust, fibreglass, polymer and organic matter. Contamination from other materials causes errors in the EDS analysis. Therefore this method was not considered to be reliable enough for automation. However, with advances of detector technology and automated computer analysis methods, a reliable method of automated asbestos identification can be achieved.

Automated Asbestos Identification Procedure using SmartPI:

Inside a fume cupboard, broken off surface samples to be analysed for asbestos are dabbed with half inch carbon sticky tabs which are already mounted on aluminium half inch stubs. The dust fully adheres to the sticky tabs and do not pose a health risk to the operator. The samples are mounted on a multi holder carousel and inserted into the SEM.

The multi holder enables efficient and less labour intensive analysis by running many samples in a single automated run Once the samples are loaded in the SEM, SmartPI automatically starts the run to analyse the samples for asbestos.

The software automatically detects the presence of asbestos. Therefore, this removed subjectivity or human error from the analysis. The system can run autonomously for 24/7 only requiring an operator to load new samples when the run is completed.

SmartPI Automated Workflow

- SmartPI automatically configures itself to the correct parameters for automated analysis.
- SmartPI aligns the SEM automatically.
- SmartPI calibrates all detectors to ensure correct operating conditions.
- SmartPI collects an image from the sample. The image is analysed and all fibres are identified.
- SmartPI breaks up the fibres into segments for EDS analysis.
- SmartPI analyses the EDS spectrum and checks if the spectrum matches its asbestos library.
- SmartPI repeats the procedure until a statistical significant number of asbestos is identified or until the whole sample is analysed.
- SmartPI automatically moves on to the next sample.
- After the auto run is complete, the user can go back to any stub and manually check if any unusual results were obtained.

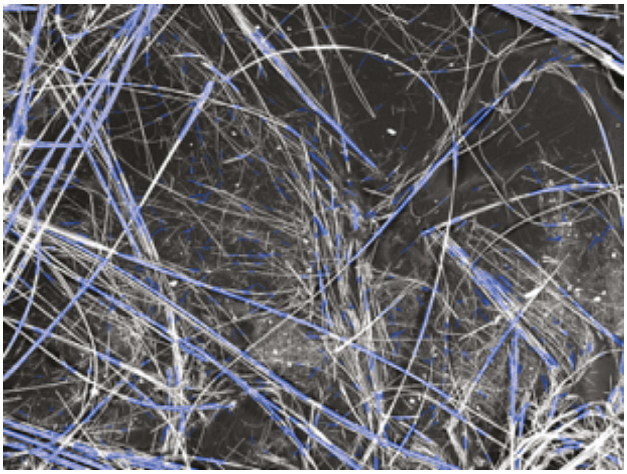


Figure 2 *Image showing 'Crocidolite' present. Blue shows where this type of asbestos is detected.*

Examples of Typical Reports

SAMPLE INFORMATION

Stub Name: 4-Chrysotile
Date of Sampling: 15/08/2013 10:10:25
Sample Name:
 # Fields Analysed: 99

Results: (Feret Max Diameter - Microns)

Classification	Total	Fibre
Chrysotile	864	864
Unclassified	92	92
Total	956	956

Chrysotile detected

SAMPLE INFORMATION

Stub Name: 5-Crocidolite
Date of Sampling: 15/08/2013 10:52:49
Sample Name:
 # Fields Analysed: 99

Results: (Feret Max Diameter - Microns)

Classification	Total	Fibre
Amosite	6	6
Crocidolite	600	600
Unclassified	557	557
Total	1163	1163

Crocidolite detected

SAMPLE INFORMATION

Stub Name: 6-Amosite
Date of Sampling: 15/08/2013 11:38:03
Sample Name:
 # Fields Analysed: 99

Results: (Feret Max Diameter - Microns)

Classification	Total	Fibre
Crocidolite	25	25
Amosite	3255	3255
Unclassified	1603	1603
Total	4883	4883

Amosite and Crocidolite detected

SAMPLE INFORMATION

Stub Name: 7-Anthophyllite
Date of Sampling: 15/08/2013 13:30:27
Sample Name:
 # Fields Analysed: 99

Results: (Feret Max Diameter - Microns)

Classification	Total	Fibre
Chrysotile	10	10
Tremolite	7	7
Anthophyllite	1413	1413
Unclassified	1974	1974
Total	3404	3404

Anthophyllite detected

SAMPLE INFORMATION

Stub Name: 8-Actinolite
Date of Sampling: 15/08/2013 14:56:20
Sample Name:
 # Fields Analysed: 99

Results: (Feret Max Diameter - Microns)

Classification	Total	Fibre
Tremolite	33	33
Actinolite	506	506
Unclassified	84	84
Total	623	623

Actinolite and Tremolite detected

SAMPLE INFORMATION

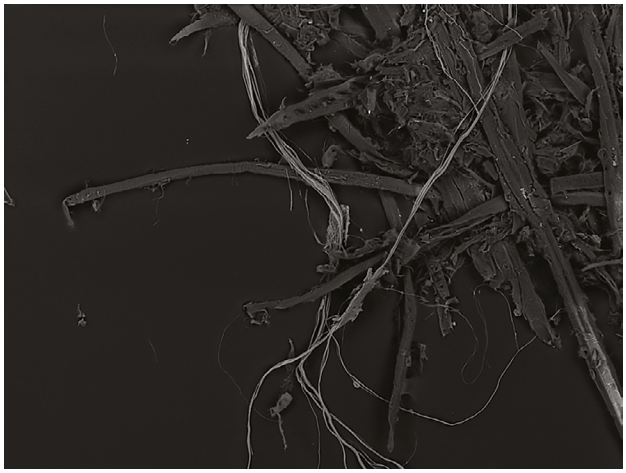
Stub Name: 9-Tremolite
Date of Sampling: 15/08/2013 15:31:32
Sample Name:
 # Fields Analysed: 99

Results: (Feret Max Diameter - Microns)

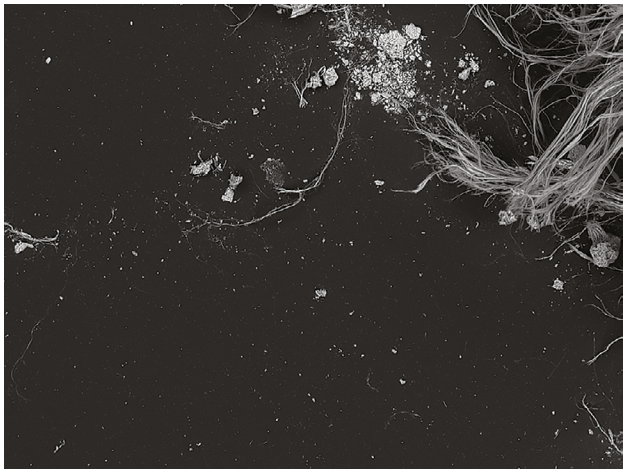
Classification	Total	Fibre
Tremolite	710	710
Unclassified	178	178
Not Classified	1	1
Total	889	889

Tremolite detected

Example Images from Asbestos Materials



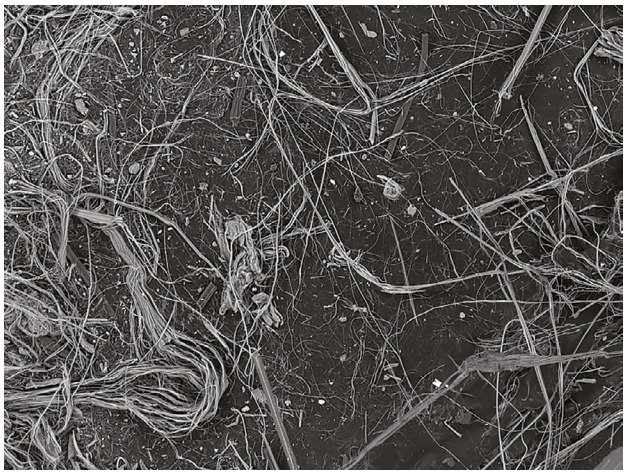
Asbestos board (Chyrsotile detected)



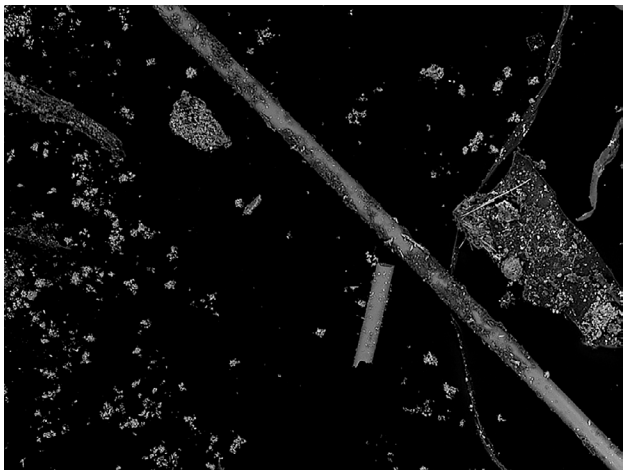
Asbestos cement (Chrysotile detected)

Asbestos paper (Chrysotile detected)

Asbestos plasterboard (Amosite detected)



Asbestos rope (Chrysotile detected)



Asbestos dust (Amosite detected)

Customer Review

"With the help of Smart PI technology asbestos detection in dust samples is easy and accurate with a fast turnaround time and analysis of number of samples also increased. Smart PI tool is user friendly to use with a minimum training anyone can use it. Our In-house recipes for Asbestos Detection works by (1) Differentiating six types of asbestos with their chemical composition, (2) High resolution pictures, and (3) Fibre Detection made easy with Image processing."

— Laxman R Kasireddy Ayerst's SEM Analyst

Summary

ZEISS Research Microscopy Solutions has created an automated asbestos identification method using a combination of SEM to identify potential asbestos fibres which is then confirmed by energy dispersive spectroscopy (EDS) through its chemical composition. The method is fast, accurate and completely automated.

Recommended System Requirements

EVO MA with LaB_6 (spare LaB_6 firing unit and anode recommended)	Sigma 300 VP
4 channel HDBSD	4 channel HDBSD push-pull
19 stub carousel	19 stub carousel
SmartPI V2.3 with EDS	SmartPI V2.3 with EDS
Oxford X-max (20 mm^2)	

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