Development of technology for visualizing asbestos in construction materials using near-infrared spectroscopy



Takao Ueno*1 (1964-)
Satoru Nakamura*1 (1975-)
Yoshitaka Yanagihara*1 (1963-)

1. Outline

The manufacture and use of asbestos are already prohibited; however, it has been sprayed on surfaces as a fire-resistant coating for steel flame of buildings and used as fiber for thermal insulation and reinforcement in the construction materials (Figure 1) of interior and exterior walls and roofs in the past. It is also required by the law to identify asbestos by preliminary survey and to remove, transport, and dispose of it properly prior to the demolition of a building skeleton in the case of demolition. The number of demolitions of private buildings possibly containing asbestos is increasing year after year, and it is estimated that it will reach a peak of approximately 100,000 buildings per year in 2028. On the other hand, certain knowledge and experience are required in the on-site visual inspections that are conducted as a part of the preliminary survey. The writer and others have developed a technology for visualizing asbestos that can detect asbestos existing within a certain range in as little as 4 seconds in order to quick screen for asbestos.

2. Content of technology

We developed the technology of detect the absorbance peak (Figure 2) of asbestos from the image of a near-infrared camera with near-infrared spectroscopy, which utilizes the characteristics of absorbing light with a specific wavelength according to the molecular structure of asbestos when it is exposed to near-infrared light.

We used an infrared camera which can measure the strength of reflected light for each pixel at once since it is required to treat a wide area in a short period of time in order to implement screening for asbestos contained in construction materials. The asbestos visualizing system was constructed by combining illumination, a liquid crystal tunable filter which can switch over the transparent wavelength and a computer (Figure 3, Table 1). Since it is easy affected by diffused light and other factors in cases where pictures are taken from a position away from the subject, various efforts were made to reduce the effect by using image processing methods. The relationship between the asbestos content (wt%) and the detection accuracy of asbestos-containing construction materials is shown (Figure 4). For construction materials containing more than 3.0wt% asbestos, the detection accuracy was 100%.

On-site screening of construction materials was implemented by bringing the system to multiple buildings prior to demolition. The experimental survey was also conducted by screening construction materials inside a van at the temporary stockyard for disaster waste in the disaster area of the Great East Japan Earthquake (Figure 5).

Also, for the purpose of reducing the risks for workers from exposure to asbestos, the automatic asbestos detection device (Figure 6), which incorporates the system and automatizes the conveyance of construction material, positioning, photographing, and detection, was developed.

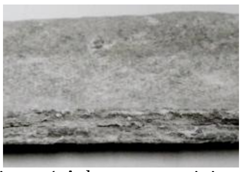

Figure 1 Asbestos-containing construction material

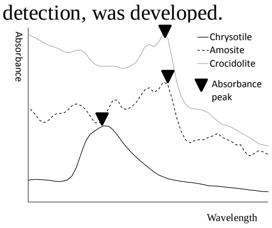

Figure 2 Absorbance peak

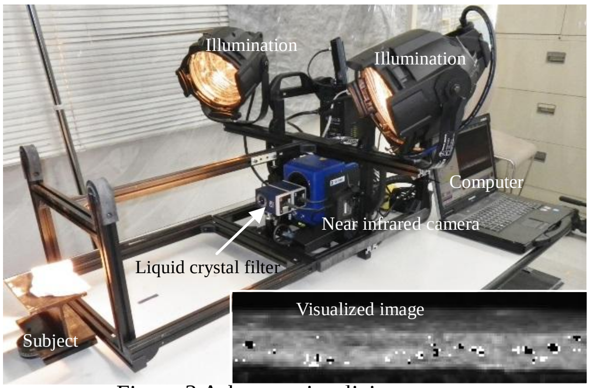

Figure 3 Asbestos visualizing system

Table 1 System specifications

Composition	Specifications
Near-infrared camera	Sensor: InGaAs, Number of pixels: 320 × 256, Wavelength: 0.9 to 1.7 μm
Filter	Method: Liquid crystal, Transparent wavelength: 0.85 to 1.8 μm, FWHM: 6 nm
Computer	Panasonic TOUGHBOOK CF-52
Subject asbestos	Chrysotile (can correspond to amosite and crocidolite)
Detection range [mm]	200 × 160 (0.6 × 0.6/pixels, Photographing distance 900 mm)
Illumination	Output 575 W × 2

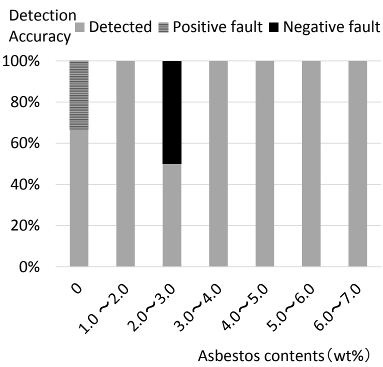

Figure 4 Asbestos detection accuracy (Total number of samples: 32)

Figure 5 Experimental investigation in disaster area

Figure 6 Automatic asbestos detection device

3. Summary

There is existing technology to detect asbestos using near-infrared spectroscopy, but technology which can detect and visualize asbestos from a distant place was not existed. It is our desire to be of a help for environmental countermeasures by developing technology that can instantly screen a wider range and adapting it to waste surveys and treatment.

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*1 Member, Tokyu Construction Co., Ltd. Institute of Technology
(Tana 3062-1, Chuo-ku, Sagamihara City, Kanagawa Prefecture 252-0244)