Abstract

[Project Information]

Project Title :	Study on Detection and Image Analysis of Asbestos on the Surface of Waste Building Materials and Its Application to Disaster Sites
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[Abstract]

Asbestos was simply detected by dyeing the surface of wasted building materials collected at disaster and demolition sites. Positively charged chrysotile was stained red purple with methylene blue (ＭＢ) and erythrosine (ＲＥＤ-３). On the other hand, negatively charged amosite was stained red with ＭＢ and ＲＥＤ-３ after the addition of positively charged poly lysine. Cellulose fibers and plastic fibers involved in building materials were stained a different color from asbestos, and glass fibers were not stained. Furthermore, since asbestos has a different shape than other fibrous materials, asbestos was clearly and selectively detected for building materials involving other fibrous compounds at a detection limit of less than 0.1% using a stereomicroscope (x 50). The present method was also applied to building materials collected at disaster sites and house demolition sites. Detected asbestos was

confirmed by polarized light microscopy (PL), X-ray diffraction (XRD), a scanning electron microscope with energy dispersive X-ray spectroscopy (SEM-EDS), Raman spectra and Fourier transformation infrared spectra (FT-IR). For 38 samples, the results in asbestos detection were compared with the results of official method of asbestos analysis recommended by Ministry of Environment, Japan. Only one sample (p-tile) showed different results between the official method and the staining method. Since this method can be performed outdoors, the application of this method facilitates the management and separation of waste building materials at disaster sites and demolition sites.

To make it easier and simpler to detect asbestos at disaster and demolition sites, AI program was developed by using a combination of wavelet analysis and machine learning. To extract structural features of asbestos, dyadic wavelet transform (DYWT) and dyadic wavelet packet transform (DYWPT) were applied to emphasize linear components in the high-frequency bands. Furthermore, empirical wavelet transform (EWT) was introduced to dynamically adapt to spectral properties, improving robustness to background variations. From the transformed images, a 42-dimensional feature vector was constructed using GLCM, GLRLM, histogram statistics, and Hessian-based edge descriptors. Classification was performed using a support vector machine (SVM), achieving 99.5% accuracy and 0.9956 F1-score. A GUI-based classification support tool was also implemented in Python, allowing users to upload microscopic images and obtain visualized asbestos detection results in approximately 22 seconds. The system provides a fast, non-destructive, and practical solution for asbestos screening and has the potential for deployment in field inspection.

[References]

Tabata M., Haraguchi R., Yada M., Umehara T., Furukawa M. (2023) "Clear and simple detection of asbestos stained with two dyes for building materials collected from disaster and demolition sites using a stereomicroscope", Waste Management, 171, p.653-661. DOI: 10.1016/j.wasman.2023.09.020

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