

SOLVING THE PROBLEM OF ARSENIC DETECTION IN VICTORIAN BOOKS WITH OPTICAL SPECTROSCOPY

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Bookbinders of the Victorian era used a green pigment, called Emerald Green, to give books a vibrant green color. This pigment, however, contains arsenic and is highly toxic. Although those books have been in circulation for almost two centuries, only recently have they been recognized as a significant health hazard. In recent years, national libraries in Germany and France have quarantined thousands of potentially arsenical books to protect staff and the public. However, not all 19th century green books contain arsenic. In fact, only a small fraction of them do. Each potentially hazardous book needs to be individually tested to confirm the presence of arsenic.

Visual identification is difficult and inaccurate, as can be seen in Fig. 1. A few instrumental detection methods exist (mainly Raman spectroscopy and X-ray fluorescence spectroscopy) with excellent accuracy. However, these methods are not suitable for large scale testing of thousands of books. Indeed, they are slow, require expensive equipment (typically tens of thousands of pounds), and specialised personnel to handle the equipment and perform data analysis. As a result, thousands of quarantined books remain untested, in absence of a solution.

That is the problem we addressed. We collected data from more than 600 19th century green books and identified a detection method based on spectral data, which relies on simpler principles than existing methods. We implemented this in a low-cost hand-held device (Fig. 2) that provides a simple "toxic" or "safe" result in milliseconds. We tested the device on a statistically representative sample of books that were independently tested with X-ray fluorescence spectroscopy, and found that the device returns 100% true positives, 0% false negatives, 12.5% false positives, and 87.5% true negatives, which makes it suitable for large scale testing. The device solves the issue of speed and cost, and will be deployed in Scottish collecting institutes in the next months.

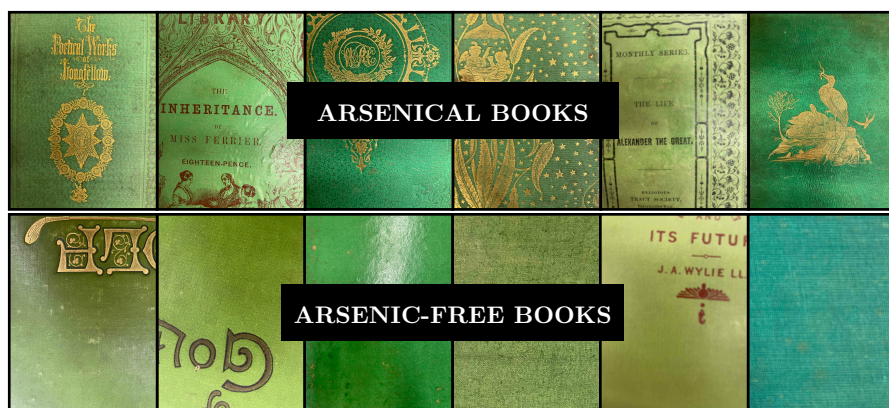


Fig. 1. Examples of arsenical and Arsenic-free books. These appear very similar, making them difficult to distinguish through visual inspection.

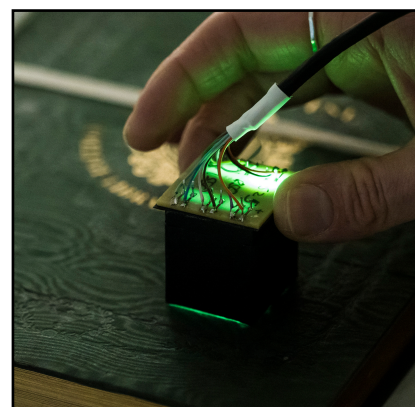


Fig. 2. Arsenic detection device.