Identifying Lead Paint with the Lumetallix Lead Test Kit: Comparison with SciAps XRF, Viken XRF, and ICP-MS Data in New York City Homes

Contact: jll2214@columbia.edu
avangeen@ldeo.columbia.edu

Jennifer L. Lamp[1], Kaveh Bastani Oskoui[2], Lukas Helmbrecht[3], Alexander van Geen[1]

[1] Lamont-Doherty Earth Observatory, Columbia University, [2] New York City Department of Health and Mental Hygiene, [3] Lumetallix BV

INTRODUCTION

Though banned from sale in the United States in 1978, residential lead-based paint continues to pose severe health hazards for young children living in New York City (NYC). Often, paint in older apartment units becomes damaged over time, exposing previously-applied lead-based paint layers. Therefore, the risk of childhood exposure to lead will remain for decades. This calls for reliable and inexpensive methods for tenants and owners to detect lead-based paint. Here we discuss ongoing work using the Lumetallix Lead Test Kit, which uses a non-toxic reagent that creates green-fluorescing crystals upon contact with lead, to determine lead sources in apartments throughout New York City. Additionally, we discuss the performance of two portable X-ray fluorescence devices in identifying lead-based paint in New York City. The results of this study are also applicable to low- and middle-income countries where lead-based paint is still widely sold.

LUMETALLIX TEST KIT

The lead test kit used in this study is a product of the Dutch company Lumetallix. It relies on a reagent – methylammonium bromide in isopropanol – which reacts to form a green-fluorescing lead perovskite visible under UV light upon contact with lead in a variety of materials. The reagent is non-toxic and can be applied by drop, spray, or rubbing.

Images from www.lumetallix.com

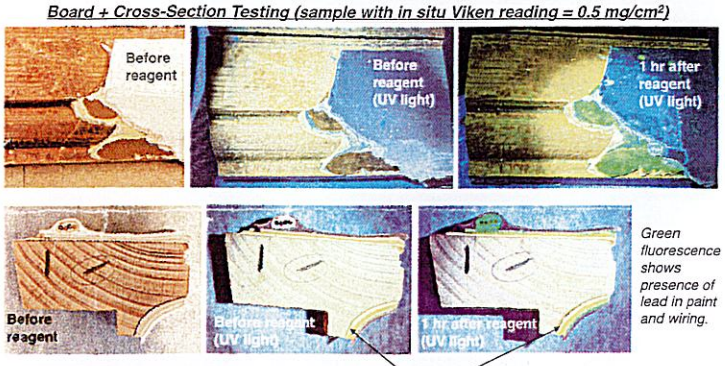
STUDY SAMPLES

With the NYC Department of Health and Mental Hygiene, we sourced 13 samples from homes undergoing abatement due to high-lead readings (> 0.5 mg/cm²), including wood-backed door frames, molding, and window frames/sills. Most samples display multiple generations of paint and contain alternating layers of lead-containing and lead-free paint.

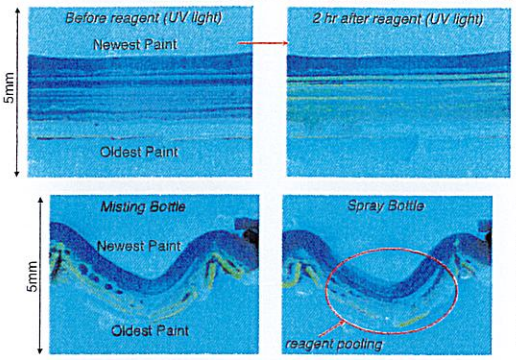
LUMETALLIX TESTING

The sample boards as well as slices exposing cross-sections of layered paint were used to examine if and how quickly paint layers fluoresce after exposure to the Lumetallix reagent. For most samples, green fluorescence is visible within seconds after adding the reagent, and grows brighter over ~30 mins to 1 hour. We find that applying the reagent using a misting bottle that produces fine droplets (versus a spray bottle or dropper bottle) provides the best results, and that light damage to the paint surface (e.g., fine scratches, etc.) can increase the brightness of the fluorescence. We also note that taking photos under UV light with a cell phone camera can help to identify fluorescing paint when it is difficult to do so with the naked eye.

Board + Cross-Section Testing (sample with in situ Viken reading = 0.5 mg/cm²)



Polished Cross-Section Testing Under Microscope



Sample with in situ Viken reading = 0.5 mg/cm². Green fluorescence is clearly identifiable using an optical microscope.

Sample with in situ Viken reading = 22 mg/cm². Photo taken 30 sec after applying Lumetallix reagent using misting bottle (left) and spray bottle (right). The spray bottle creates larger droplets that can obscure the fluorescence signal.

X-RAY FLUORESCENCE (XRF) + INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY (ICP-MS) ANALYSES

SciAps X-550

L-shell analyzer ("Surface")

Lower-energy X-ray tube source

Image: sciaps.com

Viken Pb200e

K-shell analyzer ("Deep")

Higher-energy Co-57 radioisotope source

Image: vikendetection.com

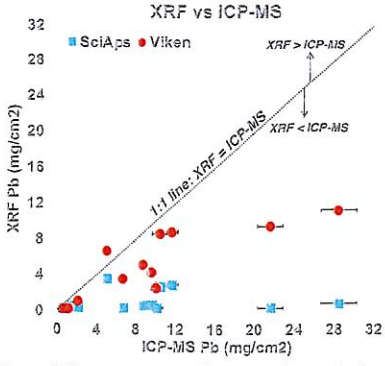
For each paint-covered board, we measured lead-concentrations using two different handheld XRF devices approved for lead testing in New York City (SciAps X-550 and Viken Pb200e), and took samples for elemental analyses via ICP-MS. Results show that the SciAps has a higher false negative rate at the NYC threshold of 0.5 mg/cm². As the total thickness of paint on the boards increases, the difference between the ICP-MS measured lead concentration and both XRF "paint-mode" device measurements increases, with the Viken generally outperforming the SciAps unit.

Sample	Viken (mg/cm²)	SciAps (mg/cm²)	ICPMS (mg/cm²)	Paint Thickness (mm)
A1	11.3	0.90	28.5 +/- 1.8	2.1
C0	9.5	0.40	21.7 +/- 1.2	1.8
H2	8.9	3.0	11.7 +/- 0.6	1.2
J3	8.7	2.7	10.6 +/- 0.9	1.1
K2	2.6	0.37	10.2 +/- 0.5	2.4
L1	4.3	0.60	9.6 +/- 0.5	2.3
D1	5.2	0.67	8.8 +/- 0.4	1.6
N1	3.6	0.47	6.8 +/- 0.3	1.9
M3	6.8	3.7	5.1 +/- 0.2	0.1
B8	1.2	0.43	2.2 +/- 0.1	1.3
F8*	0.3	0.53	1.2 +/- 0.1	1.2
I2	0.3	0.37	0.59 +/- 0.04	2.5

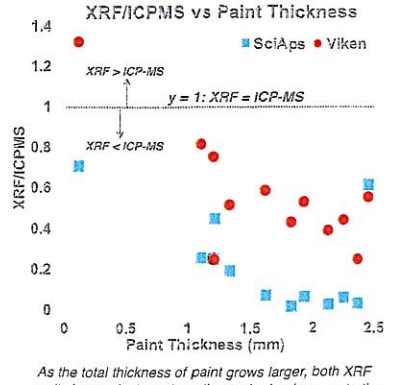
False negative at 0.5 mg/cm²

False Negative Rate: (excluding F8, n = 11):
SciAps = 45%
Viken = 9%

**Sample F8 has paint on both sides of board*



SciAps and Viken measurements diverge more from each other as the total lead concentration in the paint increases (as measured by ICP-MS).



As the total thickness of paint grows larger, both XRF units increasingly underestimate the lead concentration.

CONCLUSIONS

We demonstrate that the Lumetallix Lead Test Kit identifies high-lead paint layers in New York City apartments when paint is exposed sufficiently to the reagent. We continue to investigate the controls on fluorescence formation and best practices for large-scale deployment of the kit to the public. Our work also shows that the location of lead-based paint strongly affects the efficacy of different styles of handheld XRF units, particularly when lead-rich layers are buried under newer layers of paint. Generally, we find the Viken Pb200e unit to be more reliable than the SciAps X-550 in identifying lead-based paint requiring abatement in New York City. This work is funded by US Housing and Urban Development Lead and Healthy Homes Technical Study Grant No. NYLTS0028-24.

Though the work presented here focuses on apartments in New York City, our results are equally important for identifying lead-based paint in countries around the world where lead exposure continues to cause harm. In particular, we show that the choice of XRF device used to classify paint as lead-containing is extremely important, especially when lead-based paint is covered by non-lead containing paint. Additionally, the Lumetallix reagent has proved similarly reliable for identifying lead-containing paint in samples from a variety of countries.

Further Reading:
van Geen et al. 2024. "Lead-Based Paint Detection Using Perovskite Fluorescence and X-Ray Fluorescence." *Analytica Chimica Acta* 1307:342618. doi:10.1016/j.aca.2024.342618.