

How does the Nebraska Public Health Laboratory Identify Unknown Chemicals?

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The Chemical Terrorism Preparedness Laboratory (CTPL), a section of the Nebraska Public Health Laboratory (NPHL) Biosecurity Laboratory section, has acquired a Fourier Transform Infrared (FTIR) microscope called the Illuminat^{IR} (Smiths Detection, Inc., Danbury, CT). The Illuminat^{IR} is a light microscope which is connected to an infrared light source (**Figure 1**). Three instruments were acquired through a Nebraska Emergency Management Agency (NEMA) Critical Infrastructure Protection grant, and is being used for

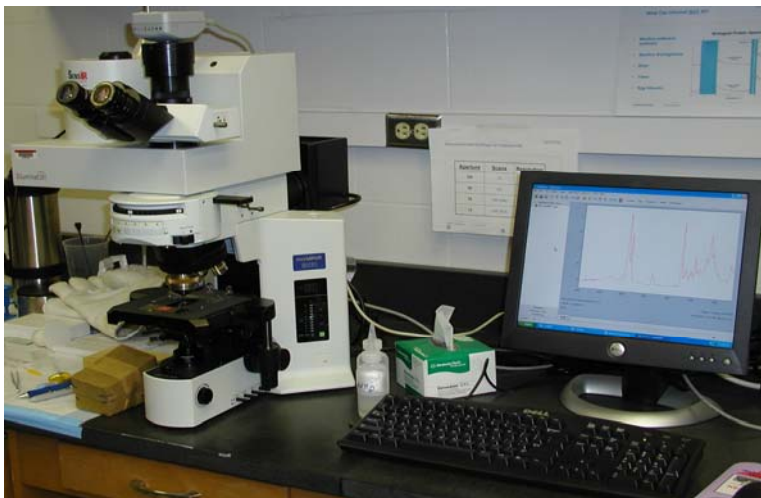


Figure 1

the analysis of unknown chemicals submitted to the laboratory by authorized law enforcement or public health officials. The Nebraska Chemical Identification Laboratory (NCIL) network includes the NPHL and the Chemistry Departments of the University of Nebraska-Lincoln, and the University of Nebraska at Kearney where the additional two units have been placed.

Infrared spectroscopy is a method that evaluates how infrared light (heat) is absorbed by the bonds between atoms that form molecules. Light of wavelengths in the infrared region have energies that are on the same order of magnitude as the vibration of bonds in molecules. Infrared radiation is experienced or recorded as heat (such as from a heat lamp), by the “warming up” of molecular bonds. The output generated by the FTIR microscope is called a spectrum; the spectrum of the molecules being analyzed is represented on a graph that shows how much infrared light is absorbed by molecules at each wavelength of infrared light. Therefore, an infrared spectrum is analogous to a fingerprint of the chemical for use in identification. Once the molecular spectrum is obtained, NPHL personnel will perform a database search on the instrument to determine a spectrum of the “best match”. A confirmatory result is achieved by electronic submission of the sample spectrum to a 24/7 consultation service called Reachback from Smiths Detection. The spectrum is reviewed by the chemists on call and a detailed report is e-mailed back within an hour.

The entire process, from sample preparation to result can be accomplished in about two hours. NPHL currently has an IR spectrum database containing thousands of chemicals including substances that could be used as weapons of chemical terrorism involving powders, liquids, explosives, hydrocarbons, toxic chemicals, and pesticides. In addition, NPHL initiated an FTIR proficiency testing (PT) program in 2005. Samples are mailed monthly to NCIL network members to maintain proficiency on the FTIR. Other entities that also receive PT samples include Lincoln-Lancaster County Health

Department, the 72nd Civil Support Team, and the Offutt Air Force Base Bioenvironmental Engineer Group. This ensures conformity in testing and reporting among different laboratories.

Although the FTIR is primarily used to identify unknown chemicals in environmental specimens such as powders, solids, liquids, and pastes, the technology is also used to identify organic materials i.e., fibers and inorganic materials i.e., mineral acids or a mixture of these components. The FTIR can also be used for clinical purposes, such as the identification of urinary crystals. Some limitations of FTIR include the inability to identify ionic salts or aqueous solutions, and the inability to identify biological agents, since a non-unique spectrum for all protein substances is generated.

The advantage of FTIR microscopy is the combination of spatial separation with the molecular identification of FTIR. For instance, **Figure 2** displays a mixture of both cellulose and glass crystals. Polarizing light can distinguish between the two crystals and give a unique IR spectrum for each.

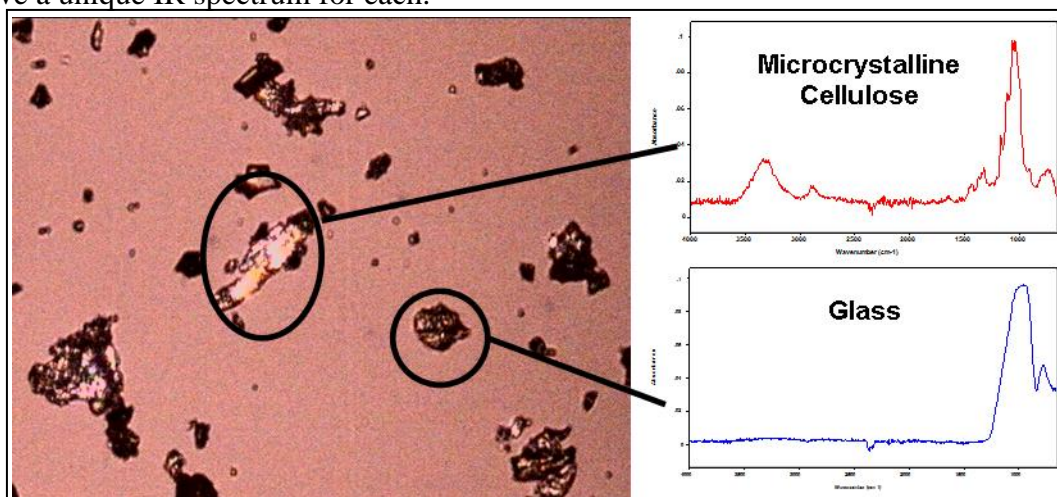


Figure 2

Overall, infrared spectroscopy is a highly specific analytical technique available at the NPHL and the NCIL laboratories for the characterization of molecular substances. This technology can be used in public health, by law enforcement personnel and for general clinical purposes. The FTIR microscope is easy to operate and results can be achieved within hours to rule-out harmful chemicals that may be associated with terrorism activity.

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