The Chemical Threat Indoor Building Materials Contamination by Airborne Chemical Warfare Agents

Chemical Warfare Agents (CWAs) are chemical substances whose toxic properties are used to kill, injure or incapacitate human beings. They are, by far, the most widely used and proliferated weapons of mass destruction, though they often get less attention than nuclear or biological weapons.
Buildings and facilities may be particularly vulnerable to attack with chemical warfare agents (CWAs). When the release of such agents is perpetrated in an enclosed place it could deliver doses high enough to injure or kill a large number of people. A release could be originated from inside the building, or targeted directly into the ventilation system.
The airborne chemical agents may penetrate porous materials in buildings, presenting residual agent off-gassing hazard afterwards. Differences in physicochemical properties of different CWAs, as well as the properties of the materials, may result in differences in persistence of the chemicals on the materials. Agent toxicity could cause lethality, by deep penetration into the human respiratory tract and/or by skin contact.
An experimental investigation has been carried out with the purpose to understand the behaviour of six materials, representative of indoor building surface, exposed to saturate vapours of three selected warfare chemical agents. This effort permitted to determine, for the different materials/agents, the contamination level, the desorption rates and agent residuals left in the sample material structure (persistence).
Building Materials, substrate sample: Plastic floor (PLF), Gypsum board painted (GYB), Raw sandstone (SDS), Painted concrete (PCN), Chem. agent resistant coating (CAR), Butyl rubber (BUR)
Chemical Warfare Agents: (CWAs): Sarin, (GB), purity 98.7%; Soman, (GD), purity 90.6%; Sulphur mustard, (HD), purity 98.5%.
The measured samples were contaminated with appropriate amount of selected CW agent in vaporized form with required and documented aerial density of contamination.

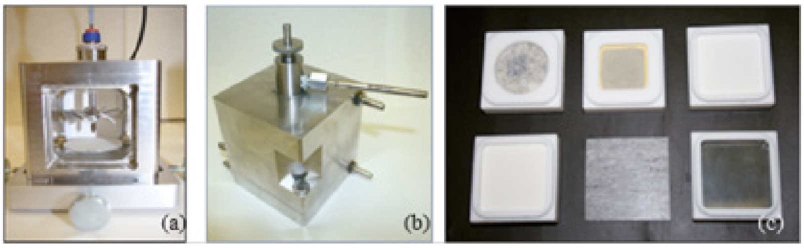

Figure 1. (a) Open contamination cell; (b) Evaporation cell; (c) Substrate samples with sealing.

For the three CWAs tested, the amounts of agent adsorbed and its persistency on the building materials increases over time with the porosity of the exposed surface.
As expected, the different building materials behave differently when exposed to the vaporised CWAs, and these differences may be rationalized in terms of physiochemical properties such as vapour pressure, diffusion, and solubility in the matrices.
The contamination density found on some materials, after exposition to the CWAs vapours, is highly above the contact threshold level.
The experimental results suggest that in buildings construction phases, when high level of resilience capability is required, suitable materials must be selected considering also their resistance to CWAs contamination.
In fact, considering the spontaneous desorption ratio behaviour, passive protective measure such as selected materials will determine survivability of critical infrastructure (CI) and also safety for the post event operations.

Ambiente
Environment

DII research group DECON/DEMIL

Renato Bonora
renato.bonora@unipd.it
Phone: +39 049 8275548

Assisted by
Dr. Stefano Miorotti
CBRN Subject Matter Expert

This work was carried out as part of a project supported by UNIFRONT Spin-off of the University of Padua.
NATO reference lab, Vyškov, CZ

Main research topics:

- Technologies against threats posed by environmental events and trends to individuals, communities or nations