Department of Chemistry

Detection of Chemical Warfare Agents using Self-Immolative Systems

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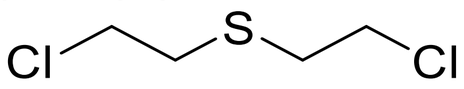
Detection of Chemical Warfare Agents (CWAs)

Chemical warfare agents (CWAs) are electrophilic in nature and are not especially easy to detect. Sulfur mustard gas (Figure 1) is a well known CWA, exposure causes blistering of the skin, damage to the eyes resulting in temporary blindness, blistering and bleeding of the respiratory system and in severe cases death.



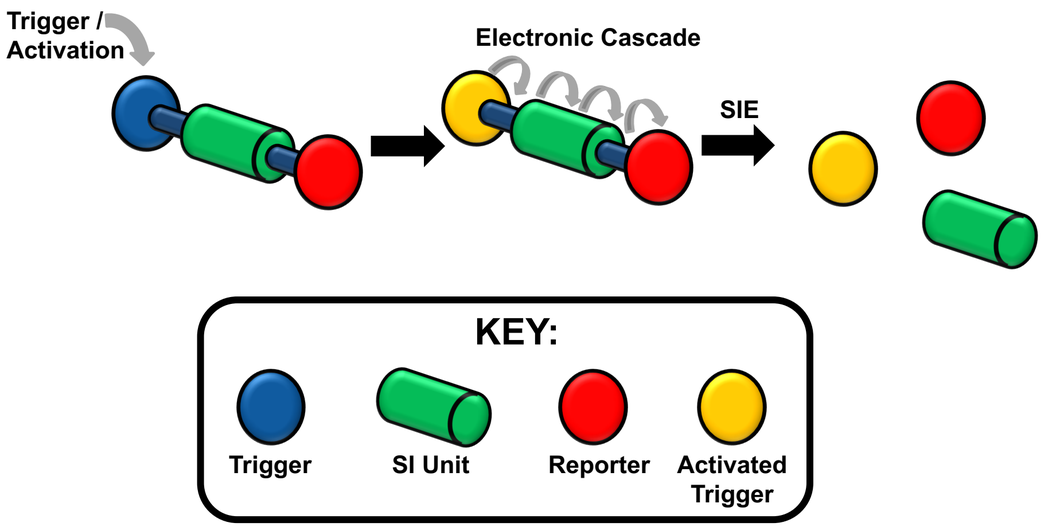
Sulfur Mustard

Figure 1. Chemical structure of sulfur mustard.

Current detection methods include GC/MS, flame photometric detectors and electrochemistry detectors, however, these methods can have slow response times. Therefore there is a direct need to develop portable sensors/detection systems that can easily and rapidly identify areas of sulfur mustard contamination.

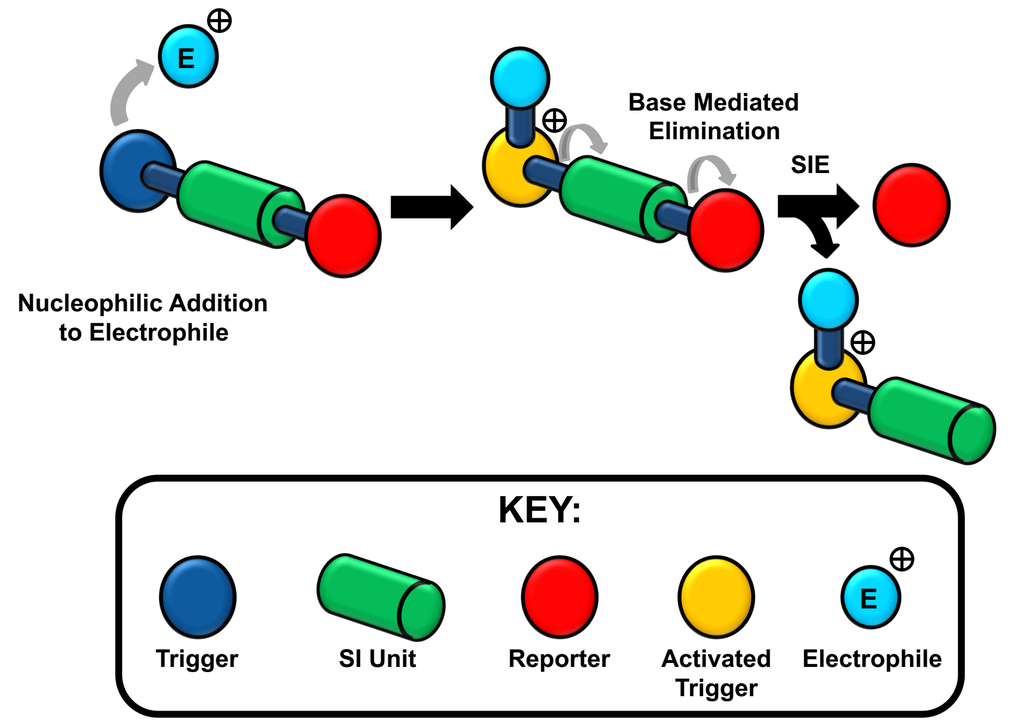
Detection of CWAs using Self-Immolative Systems

Self-immolative systems[1] are comprised of a trigger, linker and reporter moiety. Upon activation of the trigger with a specific substrate (classically a nucleophile), the linker undergoes a degradation event and releases a reporter (Scheme 1).



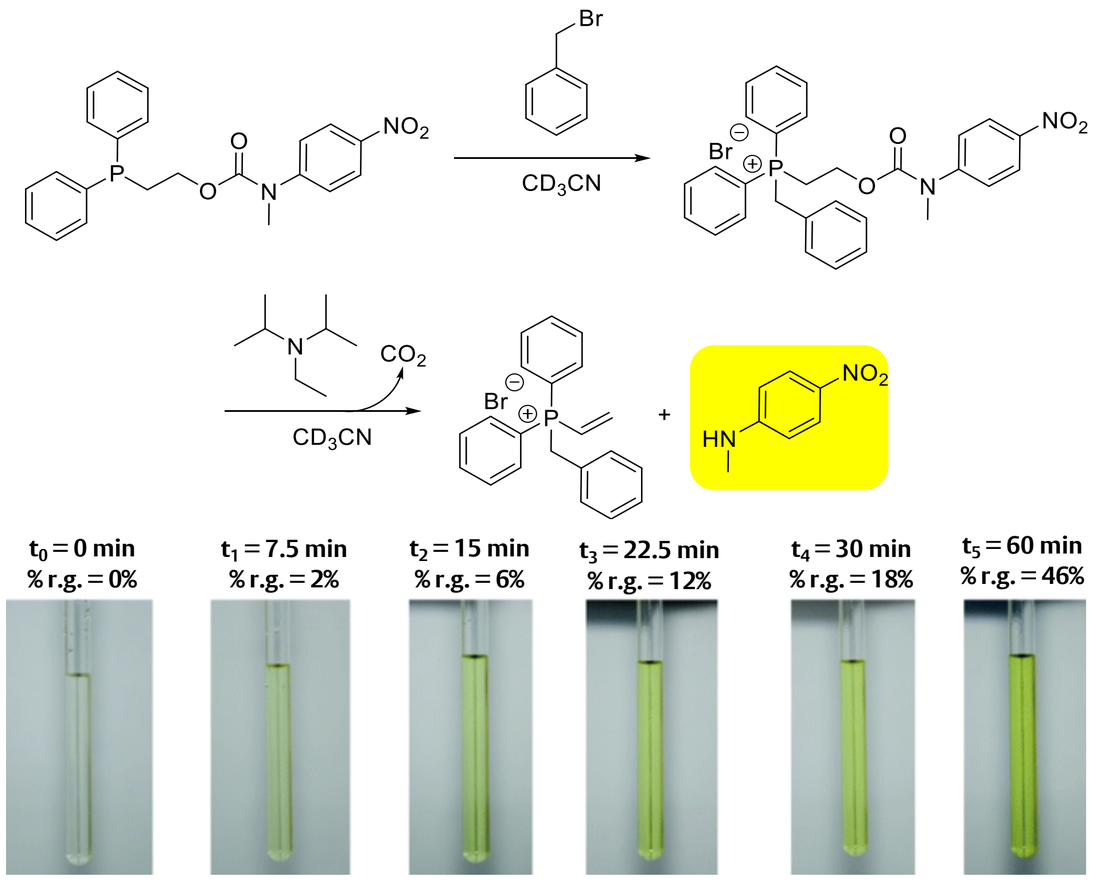
Scheme 1. Schematic representation of a 'classical' self-immolative system triggered by electrophilic substrates.

Russell *et al.*[2] reported the first example of a self-immolative system that differs from the traditional approach (Scheme 2). This system differs as the trigger attacks an electrophilic compound such as a CWA. Once the trigger has been activated by a reaction with the electrophile the self-immolative system degrades in basic medium to a release the reporter group, in this case a bright yellow colour. It is important to note that when the detector and base are mixed the degradation does not occur until it has attacked an electrophile (activation). This allows for a one-pot reaction reducing the potential complexity for the end user.



Scheme 2. Schematic representation of a self-immolative system triggered by electrophilic substrates.

The self-immolative detection system was tested as a one-pot reaction mixture with the elctrophile; benzyl bromide (a derivative of xylyl bromide, White Cross agent) and the results are shown in Scheme 4.



Scheme 3. Reaction schematic of self-immolative degradation of the disclosure system for the electrophile.

Studies are currently on going in order to optimise the physical and reactivity characteristics of the model system shown above with a view to development a simple molecular patch system for sulfur mustard.

References

1. P. L. Carl, P. K. Chakravarty and J. A. Katzenellenbogen, *J. Med. Chem.*, 1981, **24**, 479.
2. A. L. Acton, F. Leroux, A. Feula, K. Melia, M. R. Sambrook, W. Hayes and A. T. Russell, *Chem. Commun.*, 2019, **55**, 5219-5222.

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