

Amplifying Fluorescent Polymers for Detecting Hazardous Substances

Molecules, which are assemblies of atoms in particular quantities and arrangements, can be designed for a host of useful purposes. Polymers are especially useful molecules, in which a core building block molecular structure (a monomer) is repeated over and over, sometimes thousands of times, to create a chain-like structure. Basic research in nanotechnology has created polymers that detect hazardous substances with extremely high sensitivity. These polymers consist of monomers that are each about one nanometer in length. Each monomer is designed to emit light (fluoresce) when irradiated with light of a particular wavelength, but to stop fluorescing if the polymer encounters even the minutest amount of the vapor of the specific hazardous substance to be detected. Special electronics sense this loss of light emission and convert it into audio and visual alarms that signal the presence of the unwanted hazardous material. Because the monomers are chained together, they behave as a nanoscale wire that amplifies the warning signal even when only a small section of the chain actually interacts with the toxic substance. Hence these polymers are called amplifying fluorescent polymers (AFPs). They have been commercialized by ICx/Nomadics and are protecting US Army Soldiers and US Marines in Iraq and Afghanistan.



Figure. *Fido™ Amplifying Fluorescent Polymer (AFP) Devices for sensing hazardous substances: Hand held version (left panel); Robot integrated version (right panel).*

AFP technology is protecting our Soldiers and Marines and improving homeland security, e.g., at U.S. Ports of Entry, by detecting explosives and other hazardous substances.

Basic research on AFPs began under the DARPA (Defense Advanced Research Projects Agency) “Dog’s Nose Program” and continued at the Institute for Soldier Nanotechnologies (ISN), an Army Funded UARC (University Affiliated Research Center) at MIT. The ISN mission is to dramatically improve Soldier survivability by working and extending the frontiers of nanotechnology through fundamental research and transitioning (technological maturation) of promising outcomes of basic research, with ISN Army partners and industry partners.

References/Publications

Satrijo, Andrew, Steven E. Kooi, and Timothy M. Swager, “Enhanced Luminescence from Emissive Defects in Aggregated Conjugated Polymers, *Macromolecules*, 2007, 40 (25), pp 8833–8841

Patents or Other Steps Towards Commercialization

ISN industrial partner ICx/Nomadics has commercialized the AFP technology into a practical device for detecting explosives. This device, known by the trade name FIDO won 2005 and 2006 Army Best Invention Awards, and is used by U.S. Army Soldiers and U.S. Marines in Iraq and Afghanistan.

US Patent Number 7,393,503 (“Emissive polymers and devices incorporating these polymers,” Swager, et al.) is one patent governing the development of these devices.