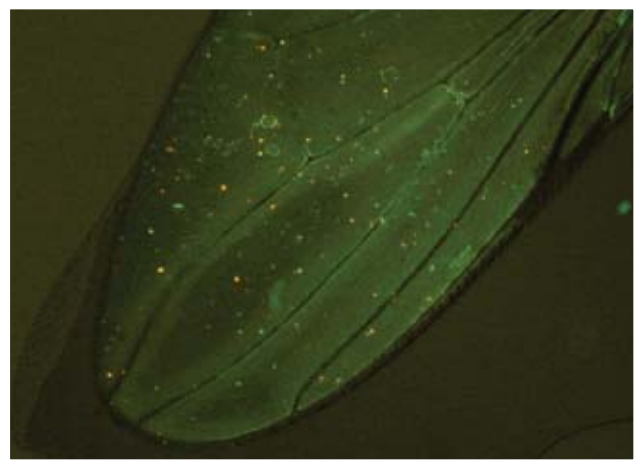
Nano-Taggants for Biological Threat Detection

Accomplishment: A nano-taggant system has been developed that can be placed on living insects. The labeling, release, recapture and identification of tagged insects was demonstrated for the first time.

Impact: Nano-tagged insects can gather illicit chemical, biological or radiological materials from the environment they travel through and deliver them for analysis, giving both composition and origin of these threats. This accomplishment provides the first demonstration of the most challenging part of the nano-taggant detection process that includes insects capture, tagging, release, recapture and positive identification.



Motivation and Approach: Military operations require early detection and analysis of chemical, biological and radiological materials used against deployed forces and civilian populations. Current sensing approaches rely on stationary collectors that require physical visits, sometimes several times a day, to monitor the collectors and verify positive indications. These fixed sensors require placement and monitoring in areas controlled by friendly forces and are subject to tampering in urban environments. Insects marked with nanotaggant technology offer an exceptionally low profile approach to gather environmental data over a much wider range of areas without alerting the target.

The process starts when nano-taggants, composed of metallic nanoparticles bound to fluorescent semiconductor quantum dots, are sprayed on the wings of captured insects. The metallic nanoparticles have specific alloy concentrations, which allow the labeled insects to be identified after recapture. The insects are released into the area to be monitored for a chosen period of time, and are later recaptured. The recaptured insects are exposed to ultraviolet or visible light that makes the nano-taggant quantum dots glow, allowing the tagged insects to be identified with hand-portable detectors that are commercially available and usable by field-grade personnel. The composition of the metallic nanoparticles attached to the quantum dots is then read like a barcode using laser-induced breakdown spectroscopy, indicating the specific lot of insects and linking them with the environment that they sampled. Any substances acquired in the insects' travels are also extracted and analyzed. The origins of the new materials are inferred from knowledge of where the insects were released and subsequently recaptured, in much the same way that the movements of tagged birds, fish or sea turtles are now routinely traced. In this demonstration, about 5% of the recaptured flies were previously labeled and released, showing for the first time that insects can be released and recaptured in this fashion.

Team: Scientists from the Human Effectiveness Directorate, led by Dr. Jonathan Kiel, modeled the natural behavior of target insects and developed nanoscale labeling materials in cooperation with NovaCentrix (supplier of metallic nanoparticles) and Evident Technologies (supplier of quantum dots). USDA entomologists collaborated in the field tests and collection of insects. The Army Research Laboratory developed the analytical method for identifying the specific nano-taggant.