PATENT
TECHNOLOGY SUMMARY
DEPARTMENT OF THE AIR FORCE TECHNOLOGY TRANSFER & TRANSITION PROGRAM OFFICE
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AFRL Scientist's Patent Makes "Heads" and "Tails" of Tricky Antibody Storage

Protecting the warfighter at all costs is the primary objective for all of the innovators working within the Air Force. But what if you could do so at a reduced cost? That's the intended result of a patent coming from the work of Patrick Dennis, Ph.D., of the Air Force Research Laboratory (AFRL).

The patent involves a process which makes "ultra-stable" antibodies. Antibodies are blood proteins that chemically bind to antigens – foreign substances that cause the body to issue an immune response – to destroy them. The problem is most antibodies require refrigeration or freezing for long-term storage. This obviously calls for equipment that may not be very practical on the battlefield.

Dennis and Joseph Slocik, Ph.D., both of the Materials and Manufacturing Directorate (RX), in collaboration with Rajesh Naik, Ph.D. former Chief Scientist from the 711th Human Performance Wing, developed a way to make the antibodies more tolerant of high temperatures. The trio have had numerous breakthroughs resulting in eight additional patents from their antibody research, which led them to this process out of an urgent need for stable biomolecules that were also heat resistant.

TECHNOLOGY

PATENT NUMBER:
US 11,338,037 B1

TECHNOLOGY NAME:
Ultrastable Antibody Ionic Liquids

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TECHNICAL PROJECT OFFICE:
AFRL Materials and Manufacturing Directorate

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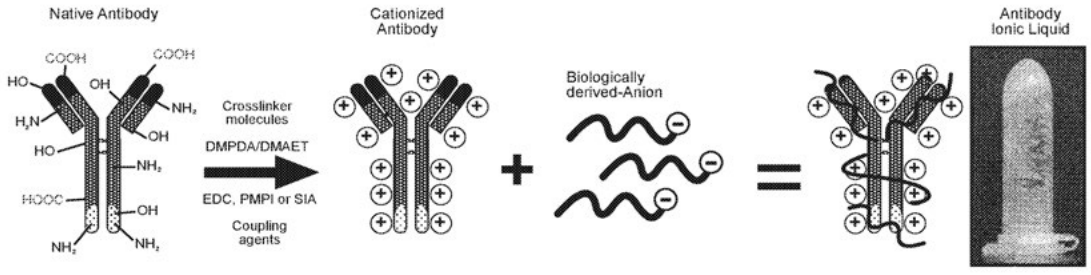

A general approach to modify any protein or antibody into a stable protein or antibody.

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"To achieve ultra-stable antibodies, primary antibodies are modified by the addition of multiple positive charges on the protein surface, electrostatically paired with stoichiometric amounts of anionic wrapping polymers to form an antibody-polymer complex, and dried via lyophilization to remove all water," Dennis explained.

What does all that mean? Dennis likened it to the concepts of freeze-drying coffee and washing clothes.

"The lyophilization process we use to drive off bulk water is basically freeze-drying. For the polymer wrapping of the antibody, I like to point out that the anionic wrapping polymer is essentially a detergent, but instead of interacting with the protein via its greasy 'tail' -- the way detergents are able to remove dirt from clothing --we're interacting the detergent with the protein using its charged 'head'. (We're) literally flipping the detergent on its head," he said.

Once the excess water is removed, the proteins interact with one another through their tails, which creates a protein-based liquid. This breakthrough, in keeping with the Technology Transfer & Transition goal, benefits both the military and the commercial sector.

"Benefits to the military include refrigeration-free storage and handling as well as the use of antibody-based vaccines or anti-venoms for treatment of military personnel against chemical and biological agents under harsh battlefield conditions," Dennis said. "These thermally-tolerant materials will significantly reduce cost and decrease the substantial weight load of specialized equipment required for refrigeration during a mission."

Commercially, in addition to being relatively easy to transport throughout the world, the polymer-wrapped proteins can be incorporated into plastics and easily produced using molds or 3D printing methods.

Dennis says he and his fellow collaborators have had so many breakthroughs in antibody research because they refused to believe in the impossible.

"Do not talk yourself out of trying out crazy new ideas," he began. "Theoretically, there are many reasons one could rationalize why this technology should not work with a complex molecule like a protein. At some point, the researcher should let nature do the thinking and perform the experiment, even though your brain is telling you it will never work."

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