

# ASU team invents technique to make sure vaccines, biospecimens stay safe at ultra-cold temperatures

**Research has moved into the real world, being adopted by labs and companies across the country**

By Jenny Green, ASU News  
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Keeping vaccines and research samples at the right temperature isn't easy, and even a brief slip can compromise their safety.

At Arizona State University, Associate Professor [Chad Borges](#) and his team have turned their research into a simple solution that is starting to see adoption by research labs and companies across the country.

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## Why this research matters

Research is the invisible hand that powers America's progress. It unlocks discoveries and creates opportunity. It develops new technologies and new ways of doing things.

Learn more about ASU discoveries that are contributing

Borges, who is a researcher in the [School of Molecular Sciences](#) and an affiliated faculty with the Biodesign Institute's Virginia G. Piper Center for Personalized Diagnostics, has developed chemical time-temperature indicators, or TTIs, that make it easy to see whether precious biological materials have been exposed to unsafe conditions.

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Most commercial indicators only work down to about -18 C, cold enough for food storage but not for science. Borges' startup, [CryoVeritas](#) has designed indicators — inspired by research from him and his students — that can stay active at much lower temperatures, down to -37 C, or even -67 C, depending on the need.

“The novelty of our indicators is that they keep running even at extreme subzero temperatures,” Borges said. “This permits them the unique ability to signal if a vaccine or biospecimen has been exposed to inappropriately warm conditions that could compromise its effectiveness.”

For example, if you leave plasma specimens at -20 C overnight and then take them out the next day, they look like little Popsicles. They may seem frozen, but they may not be. This is one of the main reasons why the team wanted to develop indicators that are active at lower temperatures.

(Video: <https://youtu.be/l8V9sfOnxB0?si=LATuVQ3kkm1NtsNr>)

## How the chemistry works

The innovation is based on a clever chemistry: a permanganate/oxalate reaction that shifts from a vivid pink color to colorless in a predictable way. At first, the indicator holds its color steady, but then it suddenly fades completely — providing a clear visual signal that time and temperature thresholds have been exceeded.

The [Borges Lab](#) and CryoVeritas' team spent years refining the reaction to make it reproducible, accurate and customizable. Their indicators can be tailored to run for set periods at temperatures ranging from -67 C to 37 C or warmer. To achieve temperatures as cold as -67 C, the team added antifreeze salts to their solutions.

Just like we add freezing-point depressants to our car radiators, the salts are perchlorates with different positive ions depending on how cold one wants to go.

The sharp color change from vivid pink to colorless is not dependent on a spectral shift like red to green. As a result, people who are colorblind can easily see the color change.

This isn't just about lab precision. The stakes are high. Biological molecules are notoriously unstable, and if their cold-chain is compromised, the results can be wasted resources, failed experiments or even reduced effectiveness of lifesaving vaccines.

CryoVeritas' TTIs offer a low-cost, easy-to-use solution that helps scientists, clinicians and biobanks ensure quality and trust in their samples. Already on the market, the technology is proof that ASU research doesn't just stay in the lab — it's solving real-world problems and protecting human health.

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## More about the work

CryoVeritas is currently expecting an infusion of funds that will greatly help to ramp up production. ASU's [Skysong Innovations](#) partnered with [General Inception, LLC](#) a startup incubator, to form CryoVeritas, Inc.

Research on the TTIs was recently published in [Chemical Engineering Journal](#), and research on the subzero-active TTIs in the Royal Society of Chemistry Journal Reaction Chemistry and Engineering, with the cover image.

Postdoctoral researcher Jorvani Cruz Villarreal served as first author on the published study, with graduate students Emil Ljungberg and Nilojan Jehanathan, as well as undergraduates Milap Owens and Anika Li, all contributing to refining and testing the devices.

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*This story originally appeared on [ASU News](#).*

## Main image



ASU researchers have invented a new technique for keeping vaccines and research samples at the right temperature. The time and temperature indicator (seen above) ranges from vivid pink to colorless. If you see any pink, all is good. If it is colorless, the sample has been compromised. Image courtesy of Jason Drees/ASU