Washington University in St. Louis
Office of Technology Management

NANOMATERIAL TO ELIMINATE COLD CHAIN BY PRESERVING BIOLOGICAL REAGENTS AND PATIENT SAMPLES

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Technology Description

An interdisciplinary team at Washington University has developed low-cost, easy-to-use, nanoparticles that can preserve antibodies, proteins and other biological molecules without refrigeration. This technology employs metal organic frameworks (MOF) that can be used in two ways to enable diagnostics and research in low-resource settings: 1) MOF can protect detection molecules (e.g., antibodies or enzymes) on biosensor surfaces to improve the stability and shelf-life of point-of-care diagnostic assays; and 2) MOF can preserve biomarker molecules in patient specimens (e.g., blood, plasma, urine) to enable shipping to centralized laboratories or research facilities.

Constant low temperatures are necessary to maintain the viability of antibodies, proteins and other biological molecules that are critical for biomedical research and diagnostics. This so-called “cold chain” can be difficult to achieve where it is often needed the most, in low-resource settings with unreliable electricity. This MOF technology could completely eliminate the need for cold storage with a protective coating that encapsulates biomolecules to preserves their activity. The MOF is composed of metal ions or clusters linked by organic ligands. It is easily removed without affecting structural integrity or downstream analysis. This convenient system could increase the shelf life and enhance the thermal stability of plasmonic biosensor chips or provide a universal sample collection technique to allow longer storage and low cost shipping of specimens on standard lab filter paper, extending the benefits of biomedical research and diagnostics to underserved populations.

ADD VIDEO HERE

Srikanth Singamaneni, associate professor of mechanical engineering and materials science, explains the MOF technology designed to protect antibody-based diagnostic sensors, and how his discovery could eliminate the need for cold storage for some medical tests.

Related Technologies: The Soft Nanomaterials Laboratory at Washington University has developed additional technologies related to diagnostics and plasmonic biosensors:

ADD TECHNOLOGIES HERE

Stage of Research

For MOF-preserved biosensors – Using IgG and NGAL (neutrophil gelatinase-associated liopocalin) model detection systems, the inventors demonstrated that bioplasmonic sensors with MOF coatings retained over 80% of their recognition capability after one week of storage at room temperature, 40°C and 60°C (compared with complete loss of recognition in unprotected samples).

For MOF-preserved specimens – Using NGAL and CA-125 as model analytes, the inventors demonstrated that samples treated with MOF and dried on a paper substrate could retain protein activity. After 2 weeks at room temperature and 40°C NGAL activity was comparable to gold standard refrigeration (-20°C).

Applications

- **Point-of-care diagnostics** – MOF reagents to preserve detection molecules on biosensors for label-free, quantitative analysis with surface plasmonic

resonance, particularly in low resource settings (e.g., homes, remote locations, developing countries, battlefields)

- **Sample collection for research and diagnostics –** refrigeration-free "biopreservation kit", particularly for collecting patient samples in low resource settings (e.g., homes, remote clinics, disaster struck areas, developing countries) to be sent to centralized laboratory for testing, with end-user applications such as:
    - large scale cancer screening
    - epidemiologic studies and remote chronic disease monitoring
    - biomarker discovery and validation
    - clinical trials for new drugs

Key Advantages

- **Preserves analytes without cold chain –** protects either the detection molecules in a diagnostic assay or the biomarkers in a patient sample, reducing transportation and storage costs
    - for biosensors: MOF encapsulation preserved antibody biorecogntion at room temperature, 40°C and 60°C
    - for protein biomarkers in urine, serum, plasma and blood samples: MOF at room temperature and 40°C was comparable to standard refrigeration for protecting specimens
    - for both biosensors and patient samples: expands access to low resource areas, either by enabling point-of-care testing or simplified shipping to centralized laboratory
- **Low cost, simple**:
    - easy to create and remove protective MOF layer
    - wide availability of MOF precursors
    - compatible with paper substrate
    - universal strategy for preserving biospecimens, applicable to existing assay types

Publications:

- Ultra-robust Biochips with Metal-Organic Framework Coatings for Point-of-Care Diagnosis Wang, C.; Wang, L.; Tadepalli, S.; Morrissey, J.; Kharasch, E.; Naik, R.*; Singamaneni, S.* 2018 *ACS Sensors*, 2018, *3*, 342-351.
- Wang, C., Tadepalli, S., Luan, J., Liu, K. K., Morrissey, J. J., Kharasch, E. D., ... & Singamaneni, S. (2017). Metal‐Organic Framework as a Protective Coating for Biodiagnostic Chips. *Advanced Materials*, 29(7), 1604433.
- Storing and testing at any temperature**,** *theSOURCE*, Jan. 4, 2017
- Wang, C., Sun, H., Luan, J., Jiang, Q., Tadepalli, S., Morrissey, J. J., ... & Singamaneni, S. (2018). Metal–organic framework encapsulation for biospecimen preservation. *Chemistry of Materials*, 30(4), 1291-1300.
- Simplifying samples, *theSOURCE*, March 2, 2018

Patents:

- WUSTL Technology No. T-016668 - Metal-organic frameworks as protective coatings and for enhancing sensitivity of biodiagnostic chips (Publication No. US20190360933)
- WUSTL Technology No. T-017288 - Methods and systems for preparing and preserving a biological sample (Publication No. WO2018195438)