ARTIFICIAL ANTIBODY PLATFORM TO ELIMINATE COLD-CHAIN IN LABEL-FREE PLASMONIC BIOSENSOR DETECTION FOR DIAGNOSTICS AND RESEARCH

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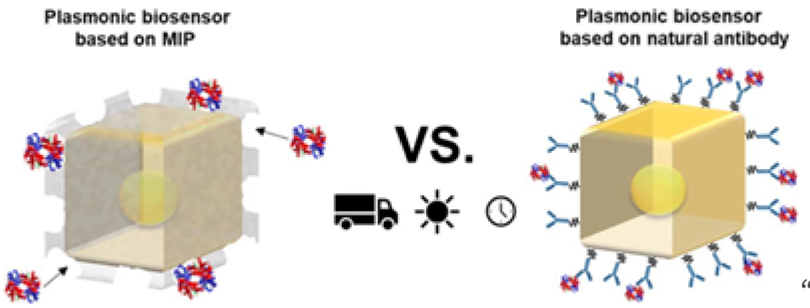
Technology Description

An interdisciplinary team of researchers at Washington University have developed a patented plasmonic nanotransducer system with built-in, highly stable artificial antibodies that can quickly detect and quantify biological molecules. These artificial antibodies can be rapidly engineered using molecularly imprinted polymers ("MIP"), for lower cost, more efficient development than traditional natural antibodies.



"MIP" (molecularly imprinted polymer) artificial antibody detection cavities on nanostructured plasmonic biosensors are more stable than natural antibodies after exposure to environmental stressors such as temperature and humidity.

Localized surface plasmon resonance (LSPR) and Raman scattering offer a powerful approach for sensitive, cost-effective point-of-care diagnostics, toxicology testing and biotechnology research. However, these label-free assays typically detect target biomarkers using natural antibodies that are costly to generate and easily lose their biorecognition ability when exposed to environmental stressors such as temperature change. Therefore, transportation and storage of the bioreagents require an expensive cold supply chain. This technology solves those problems by replacing natural antibodies with synthetic recognition elements ("artificial antibodies") formed through molecular imprinting. Because artificial antibodies offer superior stability, they could eliminate the need for cold chain logistics. Furthermore, the cost of molecular imprinting is expected to be much lower than raising and harvesting natural antibodies. Overall, we expect this durable artificial antibody platform to facilitate broad usage of plasmonic biosensors as simple, portable, accessible and affordable lab-on-a-chip detection system, particularly in low resource settings such as home care, rural clinics, developing countries and the battlefield

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

- Simple, stable plasmonic biosensors for point-of-care diagnosis of cardiac arrest and other conditions (WUSTL Technology No. T-014923)
- NEED TO ADD OTHER TECHS HERE

Stage of Research: The inventors initially demonstrated proof-of-concept by using gold nanocages with built-in artificial antibodies to detect kidney biomarkers in a clinically relevant range (down to 25 ng/ml). They further improved specificity by using PEGylation to reduce non-specific binding by a factor of 10. In addition, they demonstrated the prolonged shelf life and stability of MIP artificial antibody nanostructures by detecting a representative urinary biomarker after 2 months of storage under ambient conditions, elevated temperatures and a wide range of pH conditions.

Applications:

- **Biomarker detection platform** – molecularly imprinted polymers for label-free, quantitative antibody-like detection with plasmonic biosensors, end-user applications include:
    - clinical diagnostics and point-of-care diagnostics in low resource/austere settings such as at-home care, rural clinics, developing countries and the battlefield
    - biotechnology research

Key Advantages:

- **Stable detection to eliminate cold chain – artificial antibodies from MIPs:**
    - enable easy handling with no special storage conditions
    - retained >90% target-recognition capability after prolonged storage as well as exposure to elevated temperature and a range of pH conditions
- **Efficient, low-cost development**
    - artificial antibodies can be rapidly custom-engineered to target specific biomolecules (unlike natural antibodies which can take months or years to develop)
    - molecular imprinting costs are much lower than raising and harvesting natural antibodies
    - molecular imprinting can be efficiently integrated into micro and nanofabrication processes for transduction platforms
    - nanostructures can be reused multiple times
    - shortened development times are critical for rapidly responding to public health emergencies (such as infectious disease outbreaks) in resource-limited settings
- **Label-free detection** with plasmonic nanostructures for simple, rapid and reliable diagnostics

Publications:

- Luan, J., Xu, T., Cashin, J., Morrissey, J. J., Kharasch, E. D., & Singamaneni, S. (2018). Environmental Stability of Plasmonic Biosensors Based on Natural versus Artificial Antibody. *Analytical chemistry*, 90(13), 7880-7887.
- Luan, J., Liu, K. K., Tadepalli, S., Jiang, Q., Morrissey, J. J., Kharasch, E. D., & Singamaneni, S. (2016). PEGylated artificial antibodies: plasmonic biosensors with improved selectivity. *ACS applied materials & interfaces*, 8(36), 23509-23516.
- Tian, L., Liu, K. K., Morrissey, J. J., Gandra, N., Kharasch, E. D., & Singamaneni, S. (2014). Gold nanocages with built-in artificial antibodies for label-free plasmonic biosensing. *Journal of Materials Chemistry B*, 2(2), 167-170.
- Abbas, A., Tian, L., Morrissey, J. J., Kharasch, E. D., & Singamaneni, S. (2013). Hot spot-localized

artificial antibodies for label‐free plasmonic biosensing. *Advanced functional materials*, 23(14), 1789-1797.
- Good as gold, *theSOURCE* Oct. 22, 2015

Patents: Plasmonic biosensors with built-in artificial antibodies (U.S. Patent No. 10,241,110)

Related Web Links: Soft Nanomaterials Laboratory