

Tamper Indicating Material for High-Value Assets

Innovative Tamper Indicating Material Uses a Chemical Reaction and Color Changing Water Beads to Enhance Security Measures for Multiple Applications

Patent pending

Technology Readiness Level (TRL) 6

Business Problem

Tampering presents significant challenges that can lead to consequences including health risks and financial losses. For example, compromised medications may result in ineffective treatments or harmful side effects, jeopardizing patient safety. Current tamper-evident solutions often rely on passive indicators, such as seals or wraps, which may not provide clear evidence of tampering. Existing methods can be bypassed or manipulated even by amateur attackers. Reliance on subjective inspections introduces human error, resulting in inconsistent assessments of product integrity and increased operational costs. Unauthorized access to art or jewelry can lead to replacement with counterfeits. Additionally, tampering can manipulate results in competitive scenarios, such as voting machines or drug testing, further emphasizing the need for effective solutions.

Customer Need

Industries require reliable and innovative tamper indication systems that provide clear and immediate visual evidence of any interference to effectively address the risks posed by tampering.

Customers seek solutions that enhance security and improve operational efficiency. There is an increasing demand for technologies that reduce reliance on labor-intensive inspections. Businesses need confidence that their products remain secure throughout the supply chain. Cost-effective and versatile solutions are needed for environments such as the pharmaceutical, drug testing, and other high-value asset sectors.

Sandia Approach

Researchers at Sandia National Laboratories have developed a novel tamper indicating material using inexpensive, commercially available colored water beads combined with an irreversible color-changing chemical reaction. A chemical called L-DOPA reacts with oxygen to produce melanin, resulting in a dramatic color shift from the original color to black when exposed to air. The beads also have anti-counterfeiting properties, as the unique particle size, location, and color are encapsulated, yielding multiple identifying features. The materials can be custom fabricated into a variety of enclosure shapes and sizes, depending on the application. The material can be used broadly in the construction of tamper indicating containers and enclosures. Sandia's team is currently testing the effectiveness of these materials in extreme temperatures and following intense UV light exposure.



Competitive Advantage

Existing tamper-evident technologies often rely on subjective assessments, ineffective approaches, or complex electronic systems. Sandia's innovative solution provides a clear visual indication of tampering. The unique combination of color-changing materials enables rapid and conclusive detection of tampering, along with robust anti-counterfeiting features that set it apart in the market.

Technical Benefits

Enhanced Security: This technology provides a robust defense against tampering, ensuring high-value assets remain secure during transport and storage.

Streamlined Inspections: It eliminates the need for time-consuming manual inspections, allowing for quicker assessments of product integrity.

Confidence in Authenticity: The solution offers peace of mind through a clear visual indication of tampering, fostering trust among consumers and stakeholders.

Unique Identification: The encapsulated colored water beads create multiple identifying features, making counterfeiting extremely challenging.

Rapid Detection of Tampering Location: The irreversible color change originates at the site of tampering and expands outward, allowing for quick identification of where the tampering occurred.

Sustainability and Cost-Effectiveness: Using commercially available materials makes this technology cost-effective and sustainable.

Industries & Applications

- **Pharmaceuticals**
- **Drug Testing**
- **Art and Jewelry**
- **Cargo Containers**

Awards and Recognition

- **R&D 100 winner (2025)**



Next Steps

Sandia is seeking partners to develop and commercialize this technology. For more information, please contact Sandia National Laboratories' Licensing and Technology Transfer office.

Contact Us

SD 15314 and
SD 16693



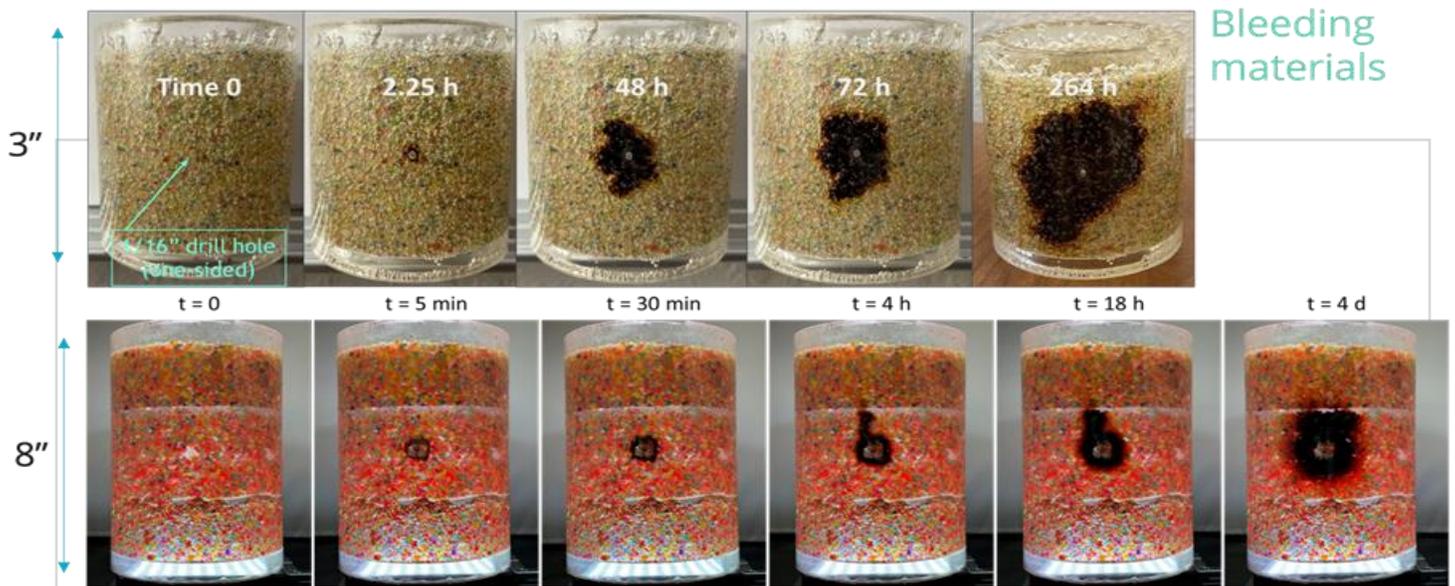
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Technical Figures



The beads irreversibly turn brown/black if someone attempts to tamper with the container. The colored speckles make each enclosure near-impossible to counterfeit.