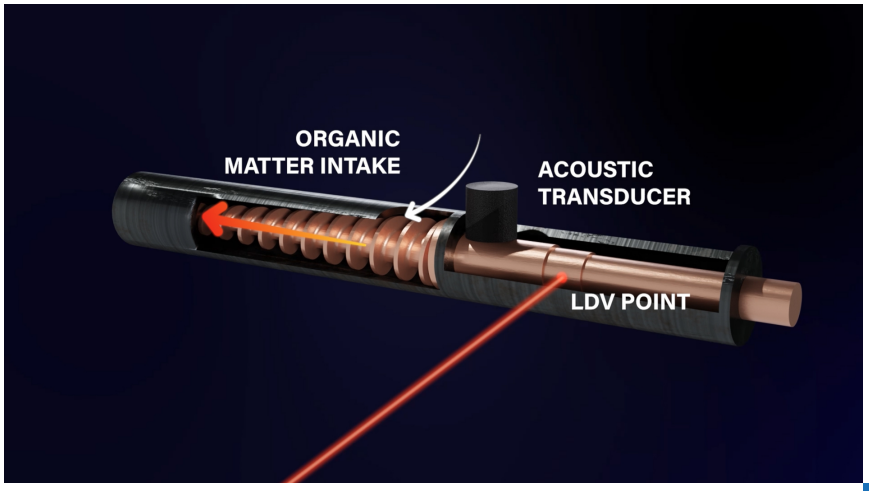

Los Alamos NATIONAL LABORATORY

Tech Snapshot

Sensors

LA-UR-23-23085

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ACOUSTIC RESONANCE SPECTROSCOPY

As applied to mechanical condition monitoring

SUMMARY

Developed at Los Alamos National Laboratory, Acoustic Resonance Spectroscopy (ARS) is a mechanical damage monitoring sensor device that prevents catastrophic mechanical failures in industrial manufacturing setting that use plug-screw feeders to transport pressurized material. Metal plug-screws are highly sensitive to changes in geometry resulting from prolonged use. When plug-screw wear isn't identified in time, failures occur and cause damage to property and decreased worker safety. The ARS solution provides continuous non-invasive acoustic monitoring with real-time alerts when set thresholds are exceeded and maintenance is required. Los Alamos is seeking a commercial partner to further prototype and develop this technology.

MARKET APPLICATION

ARS applies to the global machine conditioning market (MCM), in which sensors are used to regulate and monitor machine parts. The MCM market is growing as manufacturing facilities become more automated. ARS addresses important applications, such as plug-screw used in food processing, pharmaceutical production, oil drilling, paper production and synthesis of biofuels from waste-biomass, where machine part rotation may be too slow for existing solutions. Since the ARS approach also works with fast-rotating machinery, it enjoys a broader application range for rotating mills, lathes, turbines and windmill blades. The downtime required to inspect rotating components results in significant lost annual global productivity. ARS wear monitoring is a potential paradigm shift in wear monitoring performance.

BENEFITS

ARS replaces human visual inspection to provide continuous monitoring of critical rotating metal infrastructure alerting facility operators and other factory personnel to make important maintenance decisions based on real-time data concerning the structural health of manufacturing facilities.

- Rapid measurement times (<5 min)
- Accurate wear assessment (<0.2% of true wear)
- Noninvasive measurements (no downtime or disassembly required)
- Continuous monitoring during operation

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WHY WE ARE BUILDING ACOUSTIC RESONANCE SPECTROSCOPY

Los Alamos originally developed acoustic monitoring capabilities to identify and analyze potentially dangerous materials in closed containers without having to open any container, for applications in national security. Acoustic technology at Los Alamos evolved over the decades for broader applications, such as peering into pipes to determine real-time ratios of solid, gas and liquid contents without taking physical samples. This latest acoustic application is seen as an efficient and cost effective way to observe wear and damage phenomenon non-destructively, without disassembly. As in the aforementioned applications, ARS is non-invasive to the testing environment, interacts minimally with the device being monitored and is proven to be reliable and sensitive to the parameters being tested in real-time.

WHAT'S BEHIND OUR TECHNOLOGY

The ARS sensor continuously measures the wear and damage quantity in real-time during operation, and then alerts operators when the wear exceeds a preset threshold. Additionally, continuous wear data trends provide prediction of when plug-screw failure will occur to enable proactive maintenance scheduling.

OUR COMPETITIVE ADVANTAGES

Traditionally, operators rely on visual inspections for plug-screws, requiring halting operation and disassembling the plug-screw. These inspections incur costly downtime and are performed as infrequently as possible. Current sensors measure vibrations, pressure and temperature diagnostic approaches use passive acoustic techniques to listen for damage and wear, which is not sufficient for slow rotating plug-screws or other slow rotating components. ARS uses machine learning to identify mechanical damage respective to a given system and allows inspections to be performed without a change to operating conditions, reducing downtime, improving productivity and avoiding damaging consequences.

OUR TECHNOLOGY STATUS

The technology has been developed and implemented on lab-scale plug-screws and in simulations. The next step is to collaborate with a sensor manufacturer to build out an ARS prototype. Los Alamos is seeking a commercial partner to collaborate on further development of this technology.

PUBLICATIONS AND IP

Patents: S167557.001, patent pending

Copyrights: C23037, software copyright asserted

Publications:

1. T. Semelsberger and C. Hartford, *FCIC-DFO "Smart" Transfer Chutes with In-Line Acoustic Sensors for Bulk-Solids Handling Solutions*, ABLC2020, Online Only, 24 Jun 2020.

2. T. Semelsberger, C. Pantea, J. Greenhall, H. Doan, C. Hakoda, *DOE Bioenergy Technologies Office (BETO) 2021 Project Peer Review*, Feedstock Conversion Interface Consortium, 16 Mar 2021.

3. T. Semelsberger, *"Smart" Transfer Chutes with In-line Acoustic Sensors for Bulk-Solids Handling Solutions*, 5th Annual International Biomass Conference and Expo, Jacksonville, FL, USA, 14 Mar 2021.

4. J. Greenhall, C. Pantea, and T. Semelsberger, "Resonant acoustic monitoring of damage in augers", *J. Adv. Manuf. Proc.* E10149 (2022).

National Nuclear Security Administration