TROY TECHNICAL

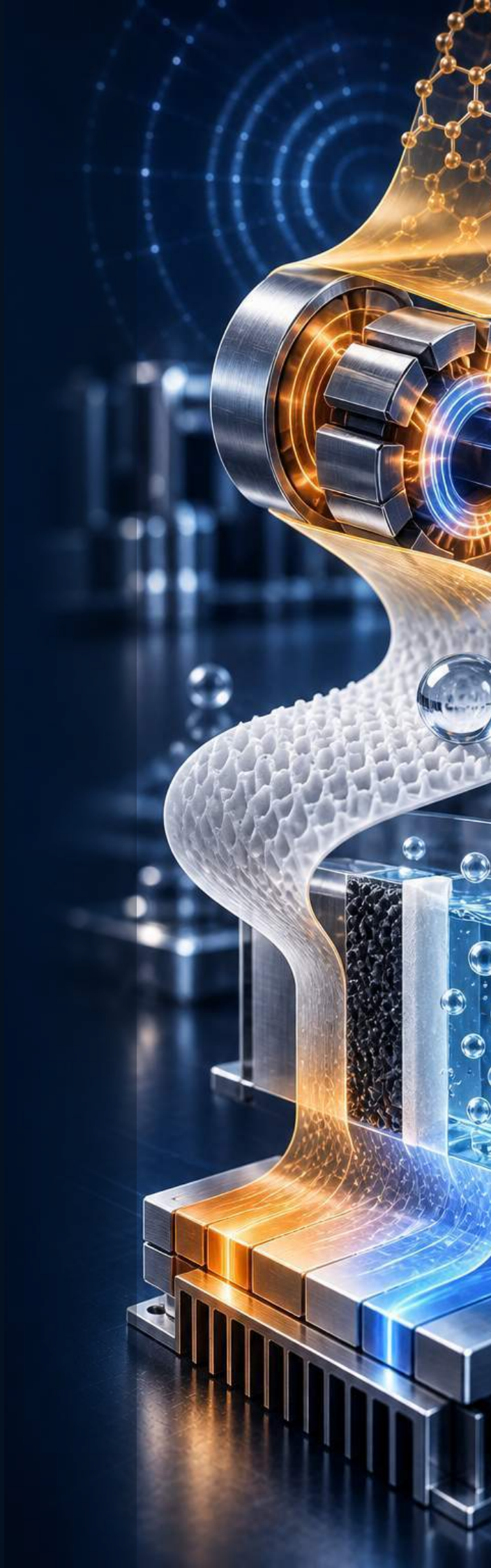
FUNCTIONAL MATERIALS
WEEKLY REPORT

November 14 - November 20, 2026 | Issue 2026-W46

Measurable device or process function, reliability and manufacturable integration

11	10
ANALYZED ARTICLES	PRIORITY THEMES

Issued 2026-11-20 | English edition | fixed approved cover artwork



Functional Materials: the boundary moved from isolated claims to qualification evidence

11 English articles were reviewed independently from the Japanese edition. Ten themes are retained for management decisions.

SIGNAL 01 | COMPOSITION

Bionic Suit: Sartexo's Muscle Fabric Specs and Commercial Roadmap

Sartexo has developed a garment-type wearable robot using " muscle fabric" that can lift objects up to 1,500 times the fabric's own weight. By integrating shape-memory alloy coils, the suit reduces lower-back muscle activity by over 40% during heavy lifting.

SIGNAL 02 | FUNCTIONAL PROPERTY

Dispersive Folded Metasurfaces: 1.339 Tbps VLC Architecture

Researchers have developed a dispersive folded metasurface (DFM) that integrates wavelength and orbital angular momentum (OAM) multiplexing to achieve an aggregate data rate of 1.339 Tbps.

SIGNAL 03 | PROCESSING

Composite Epoxy Coating: Fire-Safe LIB Thermal Runaway Specs

Researchers have developed a composite flame-retardant epoxy coating that delays lithium-ion battery thermal runaway onset by 465 s and reduces adjacent cell peak temperatures by 272 °C.

SIGNAL 04 | DEVICE INTEGRATION

SiO2/Al2O3 Hybrid Nanoparticles: Epoxy Anti-Corrosion Specs 2026

Researchers have developed an epoxy nanocomposite coating using GPMS-functionalised SiO2/Al2O3 hybrid nanoparticles that reduces corrosion current density by over two orders of magnitude on carbon steel.

DECISION

Focus this week's management attention on measurable device or process function, reliability and manufacturable integration. Move only when the linked evidence can be reproduced under your own operating conditions.

THREE MANAGEMENT MOVES

1. Buyers: prioritize performance that survives integration, aging and system-level trade-offs.
2. Suppliers: connect material property to process control, interface behavior and customer acceptance data.
3. Executives: track repeatability, interface stability, process compatibility, cost and qualification.

EVIDENCE DISCIPLINE

FACT states what the collected English source reports. BUSINESS READ and ACTION are editorial interpretations. UNKNOWN lists information that the source file does not establish. A linked article is not treated as independent confirmation of every claim.

Numbers and evidence anchors that require conditions

500 times
A05

SOURCE-BOUND CONDITION
Sartexo has developed a garment-type wearable robot using "muscle fabric" that can lift objects up to 1,500 times the fabric's own weight.

5 mm
A11

SOURCE-BOUND CONDITION
By utilizing a compact array of 40 devices within a 5×5 mm2 footprint, this architecture enables high-capacity, multidimensional visible light communication.

76.4%
A07

SOURCE-BOUND CONDITION
The coating achieves UL-94 V-0 classification and cuts total smoke production by up to 76.4%, significantly improving safety for electromobility and energy storage.

40 days
A10

SOURCE-BOUND CONDITION
The system maintains a wet adhesion strength of 9.3 MPa after 40 days of salt-water immersion, significantly improving long-term durability in aggressive environments.

99.86%
A08

SOURCE-BOUND CONDITION
Researchers have developed a fluorine-free superhydrophobic coating for 7075 aluminium alloy that achieves a corrosion protection efficiency of 99.86% and ice adhesion as low as 34 kPa.

HOW TO USE THESE NUMBERS
Each value is shown with the condition stated in the collected English article. Do not compare values across different test methods, device sizes, operating temperatures or commercial stages without normalizing those conditions.

Where the value chain moved

Each stage combines one leading theme and one supporting theme. The report treats handoffs as evidence transfers, not decorative arrows.

1

Composition

P01/P06

Sartexo has developed a garment-type wearable robot using " muscle fabric" that can lift objects up to 1,500 times the.

2

Functional property

P02/P07

Researchers have developed a dispersive folded metasurface (DFM) that integrates wavelength and orbital angular momentum.

3

Processing

P03/P08

Researchers have developed a composite flame-retar dant epoxy coating that delays lithium-ion battery thermal runaway onset by.

4

Device integr ation

P04/P09

Researchers have developed an epoxy nanocomposite coating using GPMS-functionalised SiO2/Al2O3 hybrid nanoparticles that.

5

Market adopt ion

P05/P10

Researchers have developed a fluorine-fr ee superhydrophobic coating for 7075 aluminium alloy that achieves a corrosion.

EVIDENCE REQUIRED AT EACH HANDOFF

Composition to Functional property	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck repeatability, interface stability, process compatibility, cost and qualification.
Functional property to Processing	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck repeatability, interface stability, process compatibility, cost and qualification.
Processing to Device integration	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck repeatability, interface stability, process compatibility, cost and qualification.
Device integration to Market adoption	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck repeatability, interface stability, process compatibility, cost and qualification.

COMMON CONTROL POINT

No theme moves to a commercial commitment until a named owner has reproduced the relevant evidence and documented repeatability, interface stability, process compatibility, cost and qualification.

Priority map: maturity and next decision locus



P01	Bionic Suit: Sartexo's Muscle Fabric Specs and Commercial Roadmap System / adoption | cue: Commercial
P02	Dispersive Folded Metasurfaces: 1.339 Tbps VLC Architecture Business / rules | cue: capacity
P03	Composite Epoxy Coating: Fire-Safe LIB Thermal Runaway Specs Tech / process | cue: no system/business cue
P04	SiO2/Al2O3 Hybrid Nanoparticles: Epoxy Anti-Corrosion Specs 2026 System / adoption | cue: orders
P05	Fluorine-Free Laser Coating: Durable Protection for 7075 Al Alloy Business / rules | cue: regulatory
P06	GSST-Ge Hybrid Metasurfaces: Non-Volatile Mid-IR Chiroptical Specs System / adoption | cue: system
P07	Bioresorbable Magnet Beacons: Internal Biomechanics Tracking System / adoption | cue: system
P08	ZnSb Thermoelectrics: Cost-to-Performance Ratio and 8% Efficiency Tech / process | cue: no system/business cue
P09	KNNS-BNZ-xSZ Ceramics: SrZrO3 Doping and O-T Phase Boundary Tech / process | cue: no system/business cue
P10	Lotus-Inspired Coating: NIR-Triggered Self-Healing in 15 Seconds System / adoption | cue: system

REPRODUCIBLE POSITIONING RULE

Horizontal position uses five discrete stages: Research, Prototype, Joint evaluation, Product adoption and Scale. The vertical bands classify the next decision locus: Tech / process, System / adoption, or Business / rules (including supply systems). Article-title cues take precedence; the overview is used only when the title is silent. These are categories, not impact ranks. Bubble diameter reflects the editorial score.

FACT is source-bound. BUSINESS READ, ACTION and UNKNOWN are explicit editorial layers.

P01 Bionic Suit: Sartexo's Muscle Fabric Specs and Commercial Roadmap

A05 | Composition | Joint evaluation

2026-11-18

FACT

Sartexo has developed a garment-type wearable robot using " muscle fabric" that can lift objects up to 1,500 times the fabric's own weight. By integrating shape-memory alloy coils, the suit reduces lower-back muscle activity by over 40% during heavy lifting. This technology enables a motor-less, flexible exoskeleton for industrial, medical, and elderly care applications.

WHY IT MATTERS

The decision relevance is measurable device or process function, reliability and manufacturable integration. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect material property to process control, interface behavior and customer acceptance data.

ACTION

Within 30 days, prioritize performance that survives integration, aging and system-level trade-offs; record the evidence and owner against P01.

UNKNOWN

Still unproven or incompletely stated: repeatability, interface stability, process compatibility, cost and qualification.

EDITORIAL SCORE 20/25 | MATURITY 3/5 | DECISION LOCUS: SYSTEM / ADOPTION

P02 Dispersive Folded Metasurfaces: 1.339 Tbps VLC Architecture

A11 | Functional property | Product adoption

2026-11-20

FACT

Researchers have developed a dispersive folded metasurface (DFM) that integrates wavelength and orbital angular momentum (OAM) multiplexing to achieve an aggregate data rate of 1.339 Tbps. By utilizing a compact array of 40 devices within a 5×5 mm2 footprint, this architecture enables high-capacity, multidimensional visible light communication.

WHY IT MATTERS

The decision relevance is measurable device or process function, reliability and manufacturable integration. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect material property to process control, interface behavior and customer acceptance data.

ACTION

Within 30 days, prioritize performance that survives integration, aging and system-level trade-offs; record the evidence and owner against P02.

UNKNOWN

Still unproven or incompletely stated: repeatability, interface stability, process compatibility, cost and qualification.

EDITORIAL SCORE 20/25 | MATURITY 4/5 | DECISION LOCUS: BUSINESS / RULES

FACT is source-bound. BUSINESS READ, ACTION and UNKNOWN are explicit editorial layers.

P03 Composite Epoxy Coating: Fire-Safe LIB Thermal Runaway Specs

A07 | Processing | Product adoption

2026-11-19

FACT

Researchers have developed a composite flame-retardant epoxy coating that delays lithium-ion battery thermal runaway onset by 465 s and reduces adjacent cell peak temperatures by 272 °C. The coating achieves UL-94 V-0 classification and cuts total smoke production by up to 76.4%, significantly improving safety for electromobility and energy storage.

WHY IT MATTERS

The decision relevance is measurable device or process function, reliability and manufacturable integration. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect material property to process control, interface behavior and customer acceptance data.

ACTION

Within 30 days, prioritize performance that survives integration, aging and system-level trade-offs; record the evidence and owner against P03.

UNKNOWN

Still unproven or incompletely stated: repeatability, interface stability, process compatibility, cost and qualification.

EDITORIAL SCORE 19/25 | MATURITY 4/5 | DECISION LOCUS: TECH / PROCESS

P04 SiO2/Al2O3 Hybrid Nanoparticles: Epoxy Anti-Corrosion Specs 2026

A10 | Device integration | Product adoption

Prior release 2026-11-13

FACT

Researchers have developed an epoxy nanocomposite coating using GPMS-functionalised SiO2/Al2O3 hybrid nanoparticles that reduces corrosion current density by over two orders of magnitude on carbon steel. The system maintains a wet adhesion strength of 9.3 MPa after 40 days of salt-water immersion, significantly improving long-term durability in aggressive environments.

WHY IT MATTERS

The decision relevance is measurable device or process function, reliability and manufacturable integration. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect material property to process control, interface behavior and customer acceptance data.

ACTION

Within 30 days, prioritize performance that survives integration, aging and system-level trade-offs; record the evidence and owner against P04.

UNKNOWN

Still unproven or incompletely stated: repeatability, interface stability, process compatibility, cost and qualification.

EDITORIAL SCORE 19/25 | MATURITY 4/5 | DECISION LOCUS: SYSTEM / ADOPTION

FACT is source-bound. BUSINESS READ, ACTION and UNKNOWN are explicit editorial layers.

P05 Fluorine-Free Laser Coating: Durable Protection for 7075 Al Alloy

A08 | Market adoption | Pilot

2026-11-18

FACT

Researchers have developed a fluorine-free superhydrophobic coating for 7075 aluminium alloy that achieves a corrosion protection efficiency of 99.86% and ice adhesion as low as 34 kPa. By combining femtosecond laser texturing with organic-inorganic reinforcement, the coating overcomes common durability and regulatory issues associated with fluorinated modifiers.

WHY IT MATTERS

The decision relevance is measurable device or process function, reliability and manufacturable integration. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect material property to process control, interface behavior and customer acceptance data.

ACTION

Within 30 days, prioritize performance that survives integration, aging and system-level trade-offs; record the evidence and owner against P05.

UNKNOWN

Still unproven or incompletely stated: repeatability, interface stability, process compatibility, cost and qualification.

EDITORIAL SCORE 19/25 | MATURITY 2/5 | DECISION LOCUS: BUSINESS / RULES

P06 GSST-Ge Hybrid Metasurfaces: Non-Volatile Mid-IR Chiroptical Specs

A02 | Composition | Pilot

2026-11-17

FACT

Researchers have theoretically demonstrated a reconfigurable chiral metasurface using Ge and the phase-change material Ge2Sb2Se4Te (GSST) to achieve non-volatile polarization control. The system enables circular dichroism (CD) modulation from -0.3 to -1 across the 6-8 μm band, providing a platform for dynamic infrared meta-optics.

WHY IT MATTERS

The decision relevance is measurable device or process function, reliability and manufacturable integration. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect material property to process control, interface behavior and customer acceptance data.

ACTION

Within 30 days, prioritize performance that survives integration, aging and system-level trade-offs; record the evidence and owner against P06.

UNKNOWN

Still unproven or incompletely stated: repeatability, interface stability, process compatibility, cost and qualification.

EDITORIAL SCORE 19/25 | MATURITY 2/5 | DECISION LOCUS: SYSTEM / ADOPTION

FACT is source-bound. BUSINESS READ, ACTION and UNKNOWN are explicit editorial layers.

P07 Bioresorbable Magnet Beacons: Internal Biomechanics Tracking

A03 | Functional property | Pilot

2026-11-19

FACT

Researchers have developed bioresorbable permanent-magnet nanocomposites that enable wireless, chipless monitoring of internal biomechanics during free movement. The system achieves a displacement-equivalent mean absolute error of 2.74 µm, allowing for clinical-grade intracranial pressure tracking in rat models.

WHY IT MATTERS

The decision relevance is measurable device or process function, reliability and manufacturable integration. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect material property to process control, interface behavior and customer acceptance data.

ACTION

Within 30 days, prioritize performance that survives integration, aging and system-level trade-offs; record the evidence and owner against P07.

UNKNOWN

Still unproven or incompletely stated: repeatability, interface stability, process compatibility, cost and qualification.

EDITORIAL SCORE 19/25 | MATURITY 2/5 | DECISION LOCUS: SYSTEM / ADOPTION

P08 ZnSb Thermoelectrics: Cost-to-Performance Ratio and 8% Efficiency

A04 | Processing | Pilot

2026-11-16

FACT

NIMS researchers have demonstrated that zinc antimonide (ZnSb) offers a superior balance of low material cost and power generation performance in thermoelectric devices. The team achieved a maximum conversion efficiency of approximately 8% at a temperature difference of 400K, proving the viability of cost-centric material selection for waste heat recovery.

WHY IT MATTERS

The decision relevance is measurable device or process function, reliability and manufacturable integration. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect material property to process control, interface behavior and customer acceptance data.

ACTION

Within 30 days, prioritize performance that survives integration, aging and system-level trade-offs; record the evidence and owner against P08.

UNKNOWN

Still unproven or incompletely stated: repeatability, interface stability, process compatibility, cost and qualification.

EDITORIAL SCORE 19/25 | MATURITY 2/5 | DECISION LOCUS: TECH / PROCESS

FACT is source-bound. BUSINESS READ, ACTION and UNKNOWN are explicit editorial layers.

P09 KNNS-BNZ-xSZ Ceramics: SrZrO3 Doping and O-T Phase Boundary

A01 | Device integration | Research

Prior release 2026-11-12

FACT

SrZrO3 (SZ) doping in KNNS-BNZ lead-free ceramics optimizes electromechanical strain by inducing an orthorhombic-tetragonal (O-T) phase boundary. The x = 0.015 composition achieved a piezoelectric coefficient d33 of 303 pC/N and a unipolar strain of 0.12%, offering a path toward high-performance environment-friendly piezoceramics.

WHY IT MATTERS

The decision relevance is measurable device or process function, reliability and manufacturable integration. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect material property to process control, interface behavior and customer acceptance data.

ACTION

Within 30 days, prioritize performance that survives integration, aging and system-level trade-offs; record the evidence and owner against P09.

UNKNOWN

Still unproven or incompletely stated: repeatability, interface stability, process compatibility, cost and qualification.

EDITORIAL SCORE 19/25 | MATURITY 1/5 | DECISION LOCUS: TECH / PROCESS

P10 Lotus-Inspired Coating: NIR-Triggered Self-Healing in 15 Seconds

A09 | Market adoption | Pilot

2026-11-17

FACT

Researchers have developed a shape-memory superhydrophobic epoxy coating that recovers from mechanical damage in 15 seconds under near-infrared (NIR) light. The system achieves a self-healing efficiency of 95.2% and provides durable corrosion protection for metal components.

WHY IT MATTERS

The decision relevance is measurable device or process function, reliability and manufacturable integration. The signal should be tested at the application and operating-system level, not accepted from a headline alone.

BUSINESS READ

For operating companies, compare the reported change with current qualification, sourcing and product-roadmap assumptions. For suppliers, connect material property to process control, interface behavior and customer acceptance data.

ACTION

Within 30 days, prioritize performance that survives integration, aging and system-level trade-offs; record the evidence and owner against P10.

UNKNOWN

Still unproven or incompletely stated: repeatability, interface stability, process compatibility, cost and qualification.

EDITORIAL SCORE 19/25 | MATURITY 2/5 | DECISION LOCUS: SYSTEM / ADOPTION

Playbook and 0-5 year roadmap

STAKEHOLDER	NOW | 0-30 DAYS	NEXT | 1-12 MONTHS	LATER | 1-5 YEARS
Operating companies	prioritize performance that survives integration, aging and system-level trade-offs	Run production-like qualification with explicit acceptance and stop criteria.	Build a portfolio and architecture that can absorb technology and supplier changes.
Materials, equipment and technology suppliers	connect material property to process control, interface behavior and customer acceptance data	Create shared reliability, process-window and failure-analysis data with customers.	Standardize interfaces, traceability, lifecycle support and recovery services.
Trading, investment and legal teams	Map repeatability, interface stability, process compatibility, cost and qualification.	Contract for capacity, quality, change notice, liability, alternatives and exit.	Diversify regional, technical and customer concentration risk.

ROADMAP

NOW | 0-30 DAYS
Evidence ledger
Owner: Strategy + quality
Deliverable: claim, source, condition, owner

NOW | 0-30 DAYS
Risk screen
Owner: Procurement + legal
Deliverable: unknowns, alternatives, stop

NEXT | 1-12 MONTHS
Joint qualification
Owner: R&D + supplier
Deliverable: process window and failure data

NEXT | 1-12 MONTHS
Commercial gate
Owner: Business + finance
Deliverable: unit economics and capacity

LATER | 1-5 YEARS
Platform strategy
Owner: Executive team
Deliverable: portfolio and interface roadmap

LATER | 1-5 YEARS
Service layer
Owner: Operations + channel
Deliverable: monitoring, maintenance and recovery

GO / NO-GO GATES

GATE	OWNER	REQUIRED EVIDENCE	NO-GO CONDITION
G1 Evidence	**Quality**	Source, test conditions and reproducibility	No traceable evidence
G2 Integration	**R&D**	Interface, process window and failure analysis	Cannot meet system conditions
G3 Commercial	**Business**	Capacity, total cost, contract and alternatives	Economics or supply cannot be supported
G4 Lifecycle	**Operations**	Monitoring, maintenance, change notice and exit	No accountable operating plan

ANALYZED ARTICLES | ITEMS 01-11

Every title and URL is displayed in full. URLs wrap without shortening and remain clickable. A verified-reference label means the translated HTML did not retain its original source URL.

ID	FULL ARTICLE TITLE	FULL SOURCE / VERIFIED REFERENCE URL - CLICKABLE
A01	KNNS-BNZ-xSZ Ceramics: SrZrO3 Doping and O-T Phase Boundary	https://doi.org/10.21203/rs.3.rs-11386087/v1
A02	GSST-Ge Hybrid Metasurfaces: Non-Volatile Mid-IR Chiroptical Specs	https://doi.org/10.21203/rs.3.rs-11498824/v1
A03	Bioresorbable Magnet Beacons: Internal Biomechanics Tracking	https://doi.org/10.64898/2026.11.07.760898
A04	ZnSb Thermoelectrics: Cost-to-Performance Ratio and 8% Efficiency	https://www.jst.go.jp/pr/announce/20261116-3/index.html
A05	Bionic Suit: Sartexo's Muscle Fabric Specs and Commercial Roadmap	https://en.sedaily.com/business/2026/11/18/wearable-robot-with-muscle-fabric-lifts-1500-times-its
A06	CsxWO3 Transparent Coating: Winter De-Icing and Summer Cooling	https://www.european-coatings.com/news/coatings-technologies/transparent-coating-delivers-winter-de-icing-and-summer-cooling/
A07	Composite Epoxy Coating: Fire-Safe LIB Thermal Runaway Specs	https://www.european-coatings.com/news/coatings-technologies/fire-safe-coating-delays-lithium-ion-battery-thermal-runaway/
A08	Fluorine-Free Laser Coating: Durable Protection for 7075 Al Alloy	https://www.european-coatings.com/news/coatings-technologies/fluorine-free-laser-coating-protects-aluminium-alloy-durably/
A09	Lotus-Inspired Coating: NIR-Triggered Self-Healing in 15 Seconds	https://www.european-coatings.com/news/coatings-technologies/lotus-inspired-superhydrophobic-coating-self-heals-in-15-seconds/
A10	SiO2/Al2O3 Hybrid Nanoparticles: Epoxy Anti-Corrosion Specs 2026	https://www.european-coatings.com/news/coatings-technologies/hybrid-nanoparticles-boost-epoxy-anti-corrosion-and-wet-adhesion/
A11	Dispersive Folded Metasurfaces: 1.339 Tbps VLC Architecture	https://www.newswise.com/articles/dispersive-folded-metasurfaces-for-visible-light-communications-beyond-1-tbps/?ad2f=1&aid=858972

FunctionalMaterials — Selected Articles

Date: 2026-11-21

Articles: 11

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#04 ZnSb Thermoelectrics: Cost-to-Performance Ratio and 8% Efficiency

#05 Bionic Suit: Sartexo's Muscle Fabric Specs and Commercial Roadmap

#06 Cs_xWO_3 Transparent Coating: Winter De-Icing and Summer Cooling

#07 Composite Epoxy Coating: Fire-Safe LIB Thermal Runaway Specs

#08 Fluorine-Free Laser Coating: Durable Protection for 7075 Al Alloy

#09 Lotus-Inspired Coating: NIR-Triggered Self-Healing in 15 Seconds

#10 SiO_2/Al_2O_3 Hybrid Nanoparticles: Epoxy Anti-Corrosion Specs 2026

#11 Dispersive Folded Metasurfaces: 1.339 Tbps VLC Architecture

#01 KNNS-BNZ-xSZ Ceramics: $SrZrO_3$ Doping and O–T Phase Boundary

Published November 12, 2026　Research Square（プレプリント）



OVERVIEW

$SrZrO_3$ (SZ) doping in KNNS-BNZ lead-free ceramics optimizes electromechanical strain by inducing an orthorhombic-tetragonal (O–T) phase boundary. The x = 0.015 composition achieved a piezoelectric coefficient d33 of 303 pC/N and a unipolar strain of 0.12%, offering a path toward high-performance environment-friendly piezoceramics.

IN DEPTH

Key Findings

The study identifies that the addition of $SrZrO_3$ (SZ) to (0.96- x)(K 0.48 Na 0.52) 0.96 Li 0.04 Nb 0.96 Sb 0.04 O 3 -0.04Bi 0.5 Na 0.5 ZrO 3 (KNNS-BNZ- x SZ) ceramics significantly enhances electrical properties through the creation of an O–T phase boundary. The optimal performance was observed at x = 0.015, which yielded a piezoelectric coefficient d33 = 303 pC/N, a planar electromechanical coupling factor kp = 0.39, and a large unipolar strain of 0.12%.

Technical Details

X-ray diffraction confirmed that all samples maintained a pure perovskite phase. The researchers observed that SZ doping induces a transition from an orthorhombic to a tetragonal phase. Regarding the microstructure, SEM observations indicated that increasing SZ content leads to a gradual reduction in grain size; however, excessive doping was found to compromise ceramic densification and degrade overall electrical performance.

The x = 0.015 ceramic demonstrated the following specific electrical specifications:

- Room-temperature relative permittivity: 2183
- Remnant polarization Pr: 14.7 μC/cm²
- Mechanical quality factor Qm: 65
- Curie temperature Tc: 235 °C

Dielectric-temperature measurements further revealed that the Curie temperature shifts downward following SZ modification.

Background & Context

Potassium-sodium niobate-based piezoceramics are being developed as lead-free alternatives to traditional piezoelectric materials due to their environmental friendliness and high piezoelectric performance. This research specifically focuses on the systematic investigation of how varying the SZ doping content affects the phase structure, microstructure, and resulting dielectric and ferroelectric properties of the KNNS-BNZ system.

Significance & Outlook

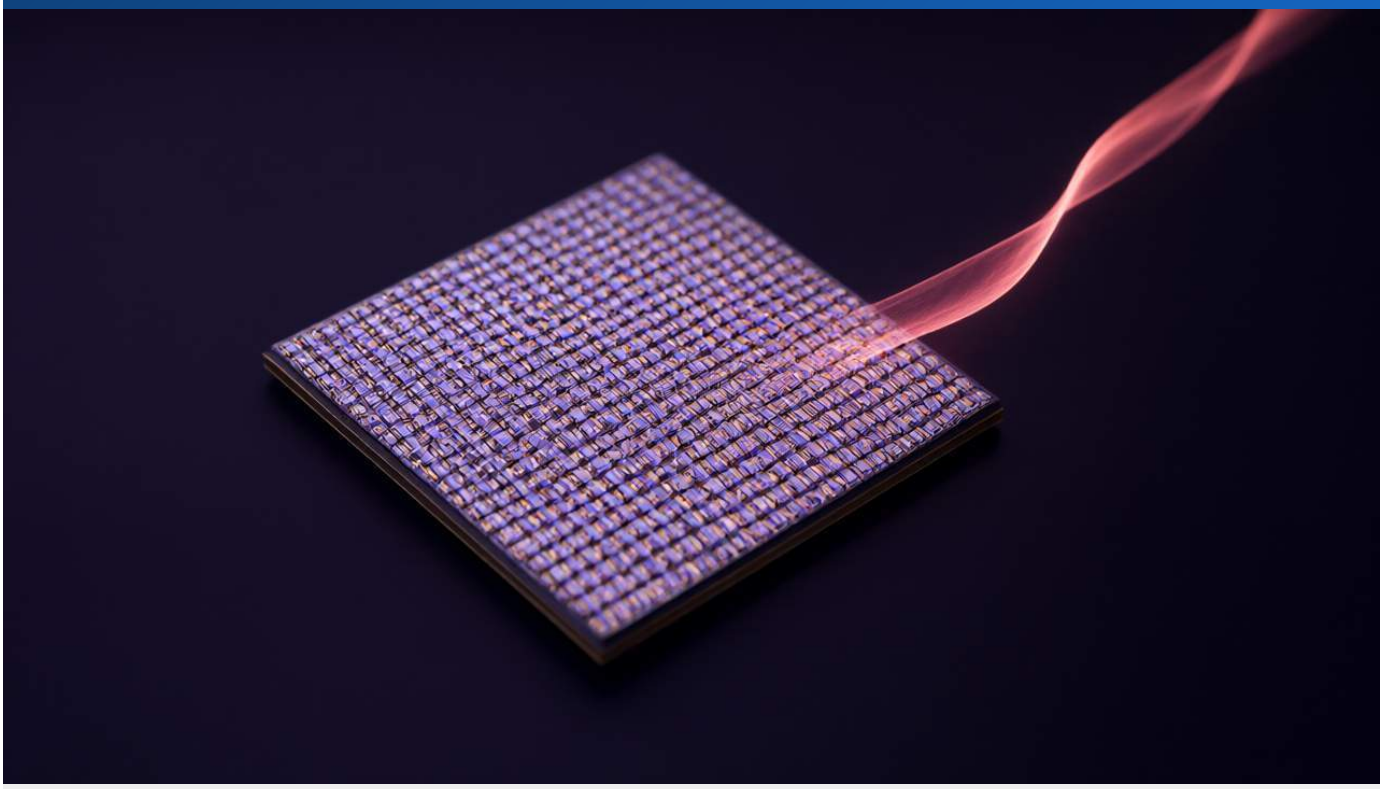
By leveraging the coexistence of the orthorhombic and tetragonal phases, this work demonstrates a method to optimize the electromechanical strain in lead-free ceramics. These results provide an experimental reference for the further performance optimization of KNNS-BNZ-based materials in piezoelectric applications.

Source: https://doi.org/10.21203/rs.3.rs-11386087/v1

Collected: November 21, 2026 | Automated Research System (AI)

#02 GSST-Ge Hybrid Metasurfaces: Non-Volatile Mid-IR Chiroptical Specs

Published November 17, 2026　Research Square（プレプリント）



OVERVIEW

Researchers have theoretically demonstrated a reconfigurable chiral metasurface using Ge and the phase-change material Ge2Sb2Se4Te (GSST) to achieve non-volatile polarization control. The system enables circular dichroism (CD) modulation from -0.3 to -1 across the 6–8 μm band, providing a platform for dynamic infrared meta-optics.

IN DEPTH

Key Findings

The proposed hybrid quasi-bound states in the continuum (quasi-BIC) active metasurface achieves significant circular dichroism (CD) modulation ranging from -0.3 to -1 within the 6–8 μm mid-infrared spectrum. By utilizing the phase-change properties of Ge2Sb2Se4Te (GSST), the system facilitates a resonance wavelength shift of $\Delta\lambda = 1.2$ μm, allowing for continuous polarization evolution across the Poincaré sphere.

Technical Details

The structure consists of Ge and GSST elliptical dimers. Technical specifications include:

- **Resonance Quality:** A quasi-BIC resonance with $Q \approx 8390$, dominated by magnetic dipole resonances to ensure strong near-field enhancement.
- **Refractive Index Contrast:** A substantial and near-lossless refractive index contrast of $\Delta n \approx 1.5$ provided by the GSST.
- **Tuning Mechanism:** Polarization states are controlled by dynamically tuning the crystallization ratio (C) from 0 to 1.
- **Polarization Conversion:** The system enables a continuous transition from elliptical toward near-circular polarization states.

Background and Context

The research addresses the demand for dynamic polarization state manipulation at the nanoscale for photonic applications. The integration of GSST as a chalcogenide phase-change material allows the metasurface to be reconfigurable and non-volatile, leveraging the material's ability to shift its optical properties based on its crystallization state.

Significance and Outlook

This high-performance platform establishes a paradigm for active infrared meta-optics. The ability to continuously tune polarization and achieve high Q-factor resonances suggests potential applications in several advanced fields, specifically polarization-encoded computing, dynamic holography, and tunable lenses.

Source: https://doi.org/10.21203/rs.3.rs-11498824/v1

Collected: November 21, 2026 | Automated Research System (AI)

#03 Bioresorbable Magnet Beacons: Internal Biomechanics Tracking

Published November 19, 2026　bioRxiv（プレプリント）



OVERVIEW

Researchers have developed bioresorbable permanent-magnet nanocomposites that enable wireless, chipless monitoring of internal biomechanics during free movement. The system achieves a displacement-equivalent mean absolute error of 2.74 μm, allowing for clinical-grade intracranial pressure tracking in rat models.

IN DEPTH

Key Findings

The developed bioresorbable permanent-magnet beacons enable the wireless tracking of internal biomechanics with high precision, achieving a displacement-equivalent mean absolute error of 2.74 μm. In rat model experiments, the system demonstrated the ability to track intracranial pressure with clinical-grade accuracy during vigorous activities and provided longitudinal monitoring of intracranial hypertension associated with ischaemic stroke during natural behaviours.

Technical Details

The beacons are synthesized from aligned iron nanowires to create bioresorbable permanent-magnet nanocomposites. These implants intrinsically generate magnetic fields that respond to biomechanical changes, eliminating the need for internal chips. To decode the resulting spatial maps, the system utilizes a wearable magnetic-field camera enhanced by artificial intelligence, which converts the data into calibrated values that remain accurate even during vigorous movement.

Background and Context

Continuous physiological monitoring is critical for reducing global health burdens associated with perioperative complications. While bioresorbable sensors are advantageous because they degrade naturally and do not require surgical extraction, traditional sensors often suffer from motion artefacts that disrupt measurement accuracy during movement.

Significance and Outlook

By combining bioresorbable materials with an AI-enhanced external camera, this technology overcomes the limitation of motion artefacts in internal monitoring. The ability to maintain accuracy during free movement and vigorous activity allows for more natural longitudinal studies of conditions such as intracranial hypertension in animal models.

Source: https://doi.org/10.64898/2026.11.07.760898

#04 ZnSb Thermoelectrics: Cost-to-Performance Ratio and 8% Efficiency

Published November 16, 2026　科学技術振興機構（JST）／NIMS 共同発表　Japan



OVERVIEW

NIMS researchers have demonstrated that zinc antimonide (ZnSb) offers a superior balance of low material cost and power generation performance in thermoelectric devices. The team achieved a maximum conversion efficiency of approximately 8% at a temperature difference of 400K, proving the viability of cost-centric material selection for waste heat recovery.

IN DEPTH

Key Findings

Researchers at the National Institute for Materials Science (NIMS) have validated the effectiveness of p-type ZnSb as a low-cost thermoelectric material. While not the highest-performing material in absolute terms, ZnSb demonstrated a high conversion efficiency relative to its raw material cost. A developed power generation module using ZnSb achieved a maximum conversion efficiency of approximately 8% under a temperature difference of 400K.

Technical Details

The study focused on reducing the economic barrier to thermoelectric deployment. The raw material cost of the developed ZnSb-based material is approximately 37.9 USD/kg. This is roughly 1/40th the cost of GeTe (germanium telluride), which exhibits the highest zT value, and 1/14th the cost of MgAgSb (magnesium silver antimonide), a current focus for high-performance materials.

To optimize the device, the team developed an Sb (antimonide) interface layer to ensure low-resistance connections between the ZnSb and the electrodes. The final module combined the p-type ZnSb (where holes carry electricity) with an n-type material (where electrons carry electricity). In terms of conversion efficiency per unit of raw material cost, the ZnSb device outperformed other representative thermoelectric devices, reaching approximately 1.7 times the efficiency of $Mg_3Sb_{1.5}Bi_{0.5}$ (magnesium antimonide bismuth) system devices.

Background & Context

Thermoelectric power generation converts unused waste heat into electricity, offering potential for energy saving and decentralized power sources. Traditionally, material evaluation has focused on the maximum "thermoelectric figure of merit zT" or absolute conversion efficiency. However, NIMS argues that practical application requires a broader evaluation including raw material costs, resource availability, environmental compatibility, and the compatibility of p-type and n-type pairs.

Significance & Outlook

This research shifts the paradigm of material selection from pursuing peak performance to optimizing the performance-to-cost ratio. Future work will focus on optimizing module structures, junction processes, scale-up verification, and long-term reliability. The team intends to expand evaluations to include manufacturing costs, supply risks, lifespan, and recyclability to realize sustainable waste heat recovery technology. The findings were published online in Nature Sustainability on November 16, 2026.

Source: https://www.jst.go.jp/pr/announce/20261116-3/index.html

Collected: November 21, 2026 | Automated Research System (AI)

#05 Bionic Suit: Sartexo's Muscle Fabric Specs and Commercial Roadmap

Published November 18, 2026 Seoul Economic Daily South Korea



OVERVIEW

Sartexo has developed a garment-type wearable robot using "muscle fabric" that can lift objects up to 1,500 times the fabric's own weight. By integrating shape-memory alloy coils, the suit reduces lower-back muscle activity by over 40% during heavy lifting. This technology enables a motor-less, flexible exoskeleton for industrial, medical, and elderly care applications.

IN DEPTH

Key Findings

The Bionic Suit, developed by Park Chul-hoon (CEO of Sartexo and principal researcher at the Korea Institute of Machinery and Materials), utilizes a specialized "muscle fabric" to assist movements of the lower back, shoulders, and elbows. Experimental data using electromyography sensors shows that wearing the suit reduces activity in lower-back muscles by more than 40% during repeated dumbbell lifts. Furthermore, the suit maintains consistent muscle activity levels over time, significantly reducing fatigue compared to lifting without assistance.

Technical Details

The core technology consists of shape-memory alloy wires processed into coils 40 micrometers thick—less than half the thickness of a human hair. While standard shape-memory alloy wire only contracts by 4% to 5%, the coil structure allows the fabric to mimic human muscle contraction, which can reach 40%. The fabric operates via thermal activation: current flows through the fabric to heat the alloy, causing it to contract and generate force. Due to the fineness of the coils, the system relaxes via air cooling without requiring a dedicated cooling device.

Safety features include:

- An insulating layer and flame-retardant materials to keep skin temperature at or below 40 degrees Celsius.
- Temperature sensors that automatically cut off power during overheating.
- Integrated cooling fans for outdoor workers in logistics and construction.

Background and Context

Research began in 2012 focusing on artificial muscles for humanoid robots before shifting toward wearable solutions for delivery drivers and laborers. The resulting "Bionic Suit Full" is the world's first garment-type robot to assist the lower back, shoulders, and elbows simultaneously in a single piece, avoiding the use of rigid frames or motors.

Significance and Outlook

Sartexo has transitioned from manual coil joining to automated weaving technology to increase productivity. The company is targeting B2B sales in defense, manufacturing, construction, and logistics, with projected pricing for lower-back models ranging from under 1 million won to the mid-1 million-won range. Future expansion into the B2C market for the elderly and people with disabilities is contingent upon obtaining medical device certification.

Source: https://en.sedaily.com/business/2026/11/18/wearable-robot-with-muscle-fabric-lifts-1500-times-its

Collected: November 21, 2026 | Automated Research System (AI)

#06 Cs_xWO_3 Transparent Coating: Winter De-Icing and Summer Cooling

Published November 20, 2026 European Coatings



OVERVIEW

Researchers have developed a transparent solid slippery coating using a phenyl/methylsiloxane network and Cs_xWO_3 nanoparticles that enables both photothermal de-icing and summer thermal management. The coating maintains over 83% visible transparency while reaching 86.5 °C under sunlight, providing an all-weather solution for outdoor optical components.

IN DEPTH

Key Findings

The developed transparent coating achieves a visible light transmittance above 83% while reaching a surface temperature of 86.5 °C under 1 sun illumination, representing an apparent photothermal conversion efficiency of 42.6%. In winter conditions, the coating demonstrates an ice adhesion strength of 56.8 kPa and an icing delay of 121 s at –20 °C without illumination. Under 1 kW/m² simulated solar irradiation, the ice-melting time on the Cs_xWO_3-20/PSO coating is 46.4% shorter than on bare glass.

Technical Details

The coating is based on a phenyl/methylsiloxane cross-linked network combined with free polydimethylsiloxane (PDMS) segments. This structure creates a liquid-lubricant-free solid slippery surface with a sliding angle of 16°. To achieve spectral selectivity, cesium tungsten bronze (Cs_xWO_3) nanoparticles are used as fillers, which provide strong absorption in the near-infrared region and relatively weak absorption in the visible range.

Regarding durability, the hybrid structure maintains stable performance after 1,000 abrasion cycles and prolonged chemical exposure.

Background & Context

Ice accumulation on outdoor optical windows is a critical challenge for UAV optoelectronic pods, automotive autonomous driving sensors, and building-integrated photovoltaic (BIPV) facades. Previous passive solutions, such as superhydrophobic surfaces and slippery liquid-infused porous surfaces (SLIPS), often suffer from lubricant depletion or wetting-state transitions. Conversely, active photothermal coatings using MXenes or carbon-based materials typically reduce optical clarity.

Significance & Outlook

Beyond winter de-icing, the near-infrared-selective absorption of Cs_xWO_3 allows the coating to act as a solar heat shield. In tests using a model house, the coating reduced indoor temperatures by 19.9 °C. By combining liquid-lubricant-free solid slipperiness, low ice adhesion, and dual-season thermal management, this technology offers a durable, all-weather solution for transparent outdoor optical components.

Source: https://www.european-coatings.com/news/coatings-technologies/transparent-coating-delivers-winter-de-icing-and-summer-cooling/

Collected: November 21, 2026 | Automated Research System (AI)

#07 Composite Epoxy Coating: Fire-Safe LIB Thermal Runaway Specs

Published November 19, 2026 European Coatings



OVERVIEW

Researchers have developed a composite flame-retardant epoxy coating that delays lithium-ion battery thermal runaway onset by 465 s and reduces adjacent cell peak temperatures by 272 °C. The coating achieves UL-94 V-0 classification and cuts total smoke production by up to 76.4%, significantly improving safety for electromobility and energy storage.

IN DEPTH

Key Findings

The developed composite coating, specifically the EP/20RMH@AP-Fe1/PEPA4 formulation, significantly enhances the thermal safety of lithium-ion batteries (LIBs). In thermal runaway propagation tests, the coating delayed the onset of thermal runaway at the directly heated Position-1 battery by 465 s. Furthermore, it reduced the peak temperature of the adjacent Position-2 battery by 272 °C compared to uncoated cells.

Technical Details

The coating utilizes a composite intumescent flame-retardant system combining two complementary agents: a biomass-based supramolecular magnesium hydroxide rod-crystal (RMH@AP-Fe) and a cage-like small-molecular charring agent, pentaerythritol phosphate (PEPA). While RMH@AP-Fe provides interfacial compatibility with the epoxy (EP) matrix, the addition of PEPA improves char-forming efficiency to create a continuous protective barrier during combustion.

Performance metrics for the optimized EP/20RMH@AP-Fe1/PEPA4 formulation include:

- **Flame Retardancy:** Achieved UL-94 V-0 classification with a limiting oxygen index (LOI) of 28.0%.
- **Smoke Suppression:** Total smoke production decreased by 76.4% and the peak smoke production rate decreased by 48.1% compared to pure EP.
- **Thermal Protection:** Confirmed fire resistance, thermal insulation, and ablation resistance through ablation tests and backside temperature measurements.

Background & Context

Epoxy resin is widely used in new energy vehicle components, such as insulating parts and battery protection housings, due to its electrical insulation, adhesion, and mechanical strength. However, its carbon- and hydrogen-rich structure typically leads to rapid flame spread and the release of dense, toxic smoke during combustion.

Significance & Outlook

The reduction in smoke and toxic gas release is critical for battery fire scenarios, as it extends evacuation time and minimizes secondary hazards. The authors suggest this multifunctional organic coating provides an innovative strategy for improving the thermal safety of LIBs in emerging energy storage and electromobility applications.

Source: https://www.european-coatings.com/news/coatings-technologies/fire-safe-coating-delays-lithium-ion-battery-thermal-runaway/

#08 Fluorine-Free Laser Coating: Durable Protection for 7075 Al Alloy

Published November 18, 2026 European Coatings



OVERVIEW

Researchers have developed a fluorine-free superhydrophobic coating for 7075 aluminium alloy that achieves a corrosion protection efficiency of 99.86% and ice adhesion as low as 34 kPa. By combining femtosecond laser texturing with organic-inorganic reinforcement, the coating overcomes common durability and regulatory issues associated with fluorinated modifiers.

IN DEPTH

Key Findings

The developed coating for 7075 aluminium alloy demonstrates a water contact angle of 163.4° and a sliding angle of 2.1°. It provides a corrosion protection efficiency of 99.86%, with charge-transfer resistance increasing from 33.76 to 2.34 × 10^4 Ω·cm^2 after 100 h of immersion in 3.5 wt.% NaCl solution. Additionally, the coating reduces ice adhesion strength from 142 kPa to 34 kPa and extends freezing time at –20 °C from 181 s to 857 s.

Technical Details

The coating process utilizes a multi-step strategy to ensure durability and hydrophobicity without using fluorine:

- **Surface Texturing:** Femtosecond laser texturing creates a biomimetic cauliflower-like hierarchical interface to maintain the Cassie-Baxter wetting state.
- **Interfacial Anchoring:** An Al-O-Si layer is formed using γ-aminopropyltriethoxysilane (KH550).
- **Reinforcement:** A spot-like reinforced skeleton is constructed using KH570-modified zinc oxide combined with low-solid-content E44 epoxy resin, which prevents the backfilling of micro/nanostructures.
- **Outer Layer:** Octadecyltrimethoxysilane (OTMS) is applied to provide a low-surface-energy finish.

Background and Context

Commercial adoption of superhydrophobic coatings for aluminium alloys has been limited by three primary factors: the regulatory scrutiny of fluorinated modifiers, weak interfacial adhesion, and the degradation of performance caused by the backfilling of micro/nanostructures. This research addresses these limitations by replacing fluorinated chemistry with a reinforced organic-inorganic structure.

Significance and Outlook

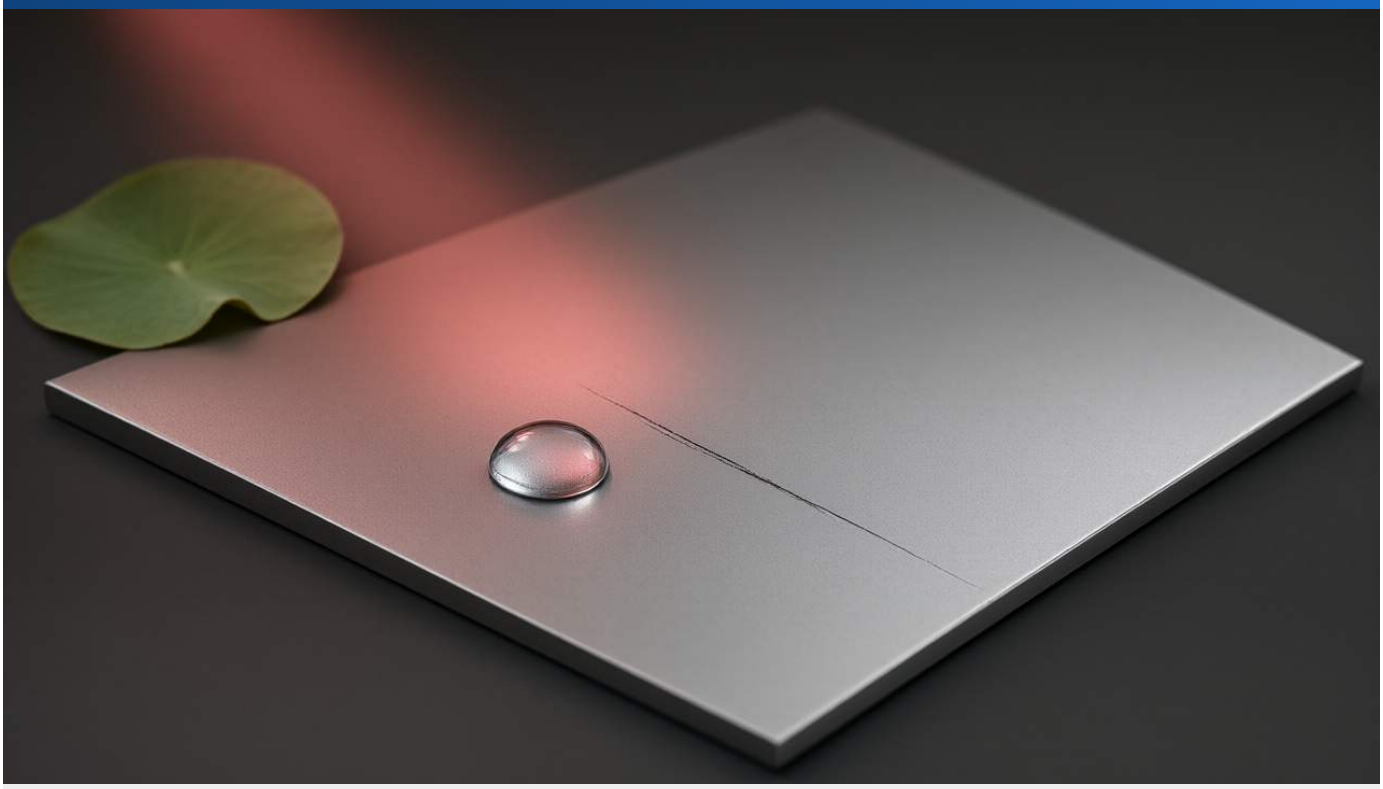
The coating exhibits high stability across various stress tests, including 240 abrasion cycles, 200 tape-peeling cycles, UV irradiation, thermal ageing, and 480 h immersion in wide-pH solutions. It also maintains low-adhesion wetting behaviour after 80 icing/de-icing cycles. Due to its durability in harsh environments, the authors suggest potential applications in the transport, marine, and aerospace sectors.

Source: https://www.european-coatings.com/news/coatings-technologies/fluorine-free-laser-coating-protects-aluminium-alloy-durably/

Collected: November 21, 2026 | Automated Research System (AI)

#09 Lotus-Inspired Coating: NIR-Triggered Self-Healing in 15 Seconds

Published November 17, 2026 European Coatings



OVERVIEW

Researchers have developed a shape-memory superhydrophobic epoxy coating that recovers from mechanical damage in 15 seconds under near-infrared (NIR) light. The system achieves a self-healing efficiency of 95.2% and provides durable corrosion protection for metal components.

IN DEPTH

Key Findings

A new shape-memory superhydrophobic epoxy coating can recover from physical damage within 15 seconds when exposed to near-infrared laser irradiation. According to electrochemical impedance spectroscopy (Bode plot integration), the self-healing efficiency reaches 95.2%. This recovery mechanism remains stable over multiple healing cycles, addressing the issue of irreversible damage accumulation typically caused by weathering, impact, or abrasion.

Technical Details

The coating's architecture is inspired by the microstructure of lotus leaves. The fabrication process involves:

- **Micro-pillar Arrays:** Shape-memory epoxy resin micro-pillars are created using a template method to form a robust structural framework.
- **Hierarchical Roughness:** Dual-scale ZIF-8 (zeolitic imidazolate framework-8) particles are sprayed onto the micro-pillar array to ensure stable superhydrophobicity.

Unlike conventional coatings where hydrophobic particles are directly exposed to wear, this design uses the micro-pillar array as a protective shield for the internal dual-scale ZIF-8 structures. This allows the surface to preserve superhydrophobicity even after the micro-pillars suffer mechanical fracture.

Background & Context

While superhydrophobic coatings are valuable for corrosion protection in industrial and marine environments, commercial adoption has been limited by high susceptibility to mechanical damage and poor long-term stability. The researchers addressed these limitations by combining the shape-memory behavior of the epoxy matrix with a biomimetic structural design.

Significance & Outlook

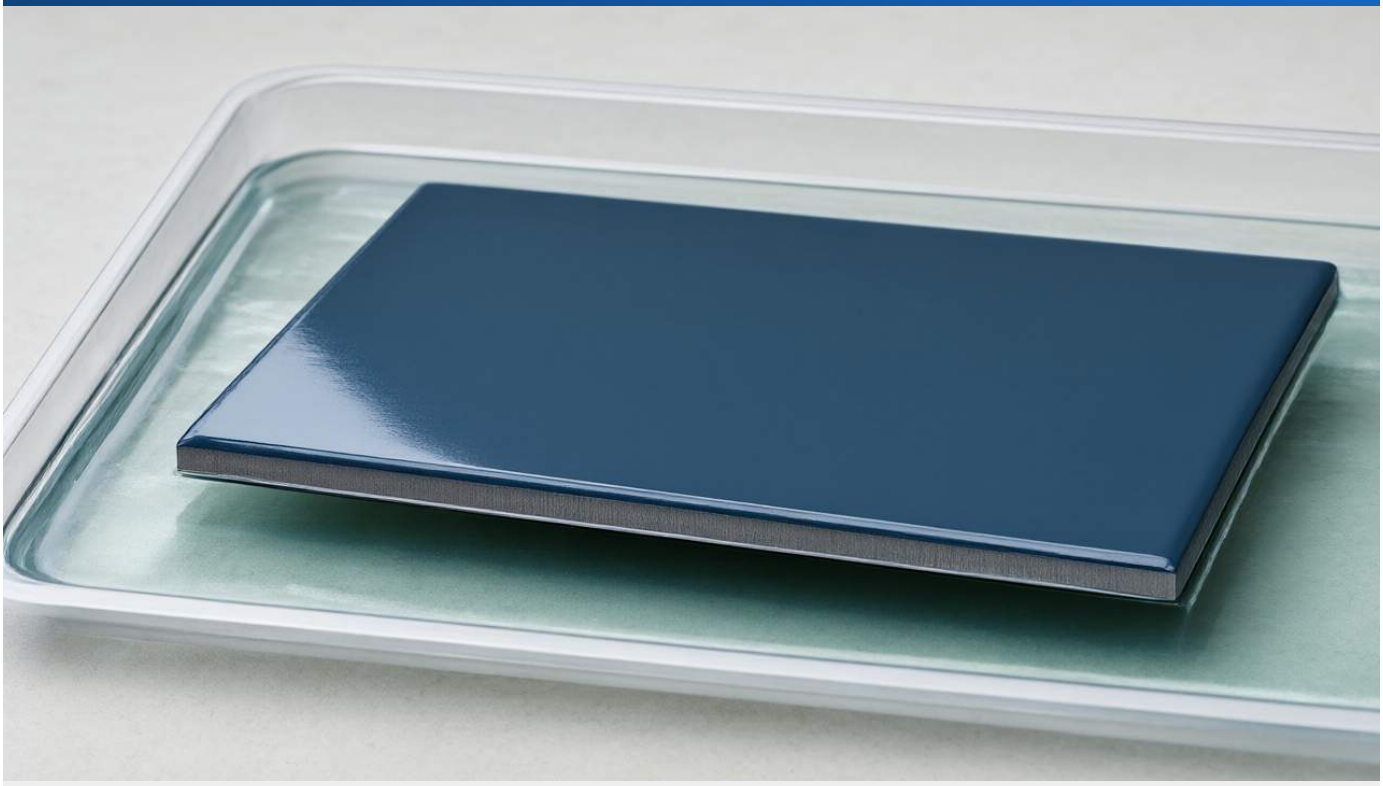
The coating demonstrates strong barrier performance, maintaining corrosion protection over 28 days of immersion testing. The synergy between the ZIF-8 particles and the micro-pillar scaffold ensures consistent superhydrophobic behavior even after multiple abrasion cycles. This strategy offers a viable route to overcoming the durability weaknesses of superhydrophobic surfaces, particularly for the protection of metal components in engineering and marine service environments.

Source: https://www.european-coatings.com/news/coatings-technologies/lotus-inspired-superhydrophobic-coating-self-heals-in-15-seconds/

Collected: November 21, 2026 | Automated Research System (AI)

#10 SiO_2/Al_2O_3 Hybrid Nanoparticles: Epoxy Anti-Corrosion Specs 2026

Published November 13, 2026 European Coatings



OVERVIEW

Researchers have developed an epoxy nanocomposite coating using GPMS-functionalised SiO_2/Al_2O_3 hybrid nanoparticles that reduces corrosion current density by over two orders of magnitude on carbon steel. The system maintains a wet adhesion strength of 9.3 MPa after 40 days of salt-water immersion, significantly improving long-term durability in aggressive environments.

IN DEPTH

Key Findings

The hybrid coating containing 1 wt.% SiO_2 and 1 wt.% Al_2O_3 (1S1A) demonstrated a dramatic increase in corrosion resistance compared to neat epoxy and single-filler systems. Potentiodynamic polarisation measurements showed a reduction in corrosion current density (Icorr) from 0.1425 to 0.0005 µA/cm². Furthermore, the 1S1A coating limited water uptake to 5.09% after 40 days of immersion in a 3.5 wt.% NaCl solution, while maintaining a high low-frequency impedance modulus throughout the period.

Technical Details

To prevent nanoparticle agglomeration and improve polymer compatibility, researchers chemically modified the oxide nanoparticles with 3-glycidoxypropyltrimethoxysilane (GPMS). This covalent grafting was verified using thermogravimetric analysis (TGA) and Fourier-transform infrared spectroscopy (FTIR). The resulting epoxide-functional silane layer ensured better dispersion and allowed the fillers to integrate covalently into the epoxy network during the curing process.

Regarding wet adhesion, the 1S1A coating retained a pull-off strength of 9.3 MPa after 40 days of immersion, representing a loss of only 24.39% ± 0.68%. In contrast, neat epoxy coatings lost 54.55% ± 1.13% of their pull-off adhesion strength under the same conditions.

Background & Context

Standard neat epoxy coatings are prone to curing-induced micropores. These defects allow the diffusion of chloride ions, oxygen, and water toward the substrate interface, which typically results in cathodic delamination, hydrolytic degradation, and under-film corrosion. This study targeted St-37 carbon steel to address these vulnerabilities.

Significance & Outlook

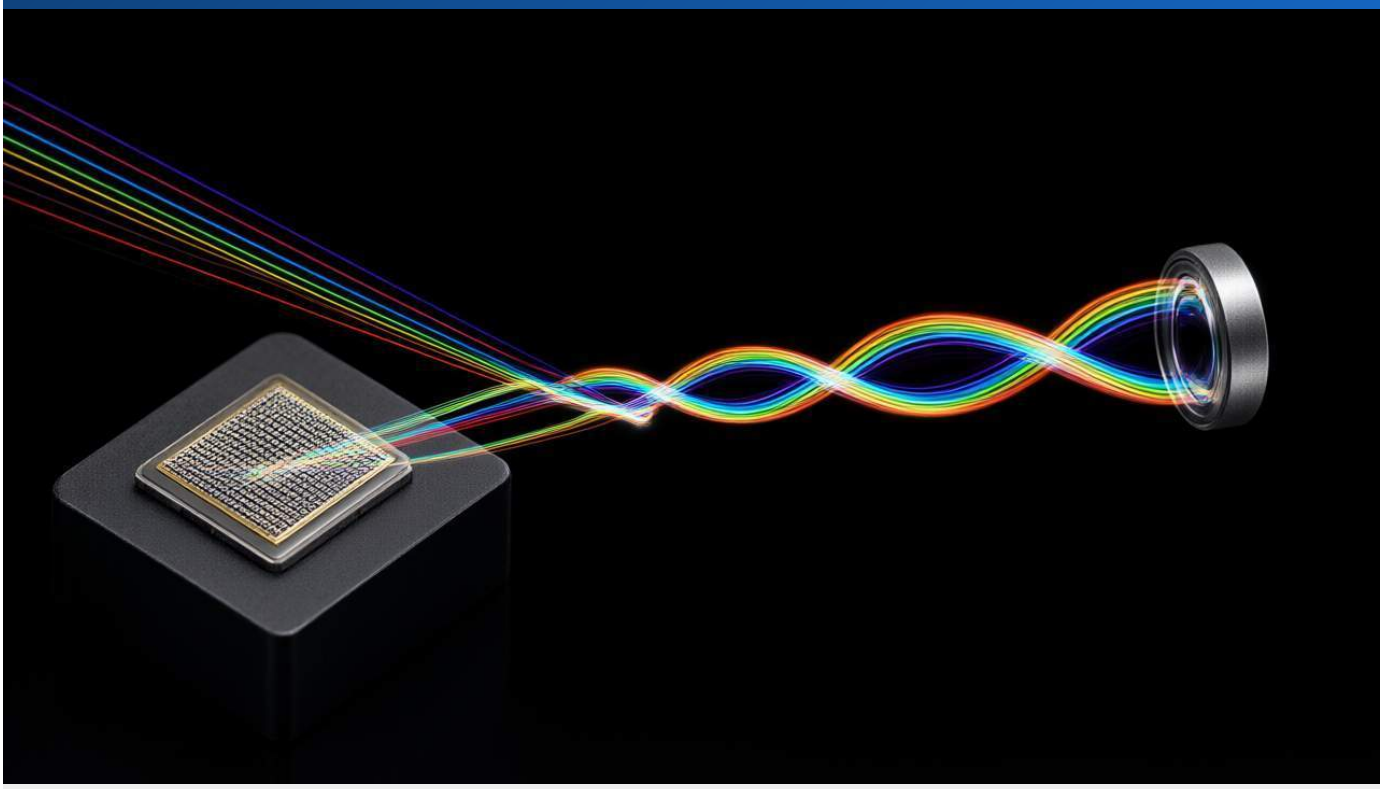
The performance boost is attributed to a synergistic effect where SiO_2 provides pore-filling capabilities while Al_2O_3 provides covalent interfacial anchoring. This combination creates a dense, defect-free network that effectively suppresses electrolyte ingress and prevents delamination, offering a more durable solution for long-term metal protection in saline environments.

Source: https://www.european-coatings.com/news/coatings-technologies/hybrid-nanoparticles-boost-epoxy-anti-corrosion-and-wet-adhesion/

Collected: November 21, 2026 | Automated Research System (AI)

#11 Dispersive Folded Metasurfaces: 1.339 Tbps VLC Architecture

Published November 20, 2026 Newswise China



OVERVIEW

Researchers have developed a dispersive folded metasurface (DFM) that integrates wavelength and orbital angular momentum (OAM) multiplexing to achieve an aggregate data rate of 1.339 Tbps. By utilizing a compact array of 40 devices within a 5×5 mm² footprint, this architecture enables high-capacity, multidimensional visible light communication.

IN DEPTH

Key Findings

A research team from Harbin Institute of Technology, Shenzhen, Fudan University, and Pengcheng Laboratory has demonstrated a dispersive folded metasurface (DFM) capable of an aggregate data rate of 1.339 Tbps. This performance was achieved using an array of 40 DFM links, resulting in 240 hybrid channels. The system delivers an average data rate of 33.47 Gbps per DFM and 5.58 Gbps per channel, with a footprint-normalized capacity density of 53.56 Gbps/mm².

Technical Details

The DFM integrates multiple metasurfaces along a folded optical path within a glass substrate. The architecture functions as follows:

- **Transmitter:** Converts independently modulated Gaussian beams from a laser-diode (LD) array into coaxially propagating wavelength–OAM channels.
- **Receiver:** Demultiplexes these hybrid channels back into a spatially separated Gaussian-beam array for detection by a photodiode (PD) array.
- **Mechanism:** The system leverages natural angular dispersion of the first diffraction order to separate discrete wavelengths along one axis, while coordinate transformation sorts OAM states along the orthogonal axis.

The researchers tested a five-metasurface device (0.22 mm²) supporting 54 channels (six wavelengths and nine OAM states) with an average mode purity of 91%. For high-speed communication, a simplified three-metasurface design supporting two wavelengths and three OAM states was used, with the top-performing channel reaching 5.79 Gbps. The system also successfully demonstrated 4K video streaming.

Background & Context

Visible light communication utilizes unlicensed spectrum, but single-channel rates are typically limited by light-source bandwidth. While wavelength and OAM multiplexing can increase capacity, integrating separate functional subsystems is complex. Previous zeroth-order multilayer architectures required stringent dispersion and fabrication to achieve distinct phase responses at closely spaced wavelengths.

Significance & Outlook

The DFM approach reduces the need for extreme local dispersion control, providing a scalable framework for optical interconnects. Potential applications include short-reach chip-to-chip and board-level links. The researchers suggest the physical principles could be extended to telecommunications C and L bands, with polarization offering a further multiplexing dimension for future wafer-scale optical front-ends.

Source: https://www.newswise.com/articles/dispersive-folded-metasurfaces-for-visible-light-communications-beyond-1-tbps/?ad2f=1&aid=858972

Collected: November 21, 2026 | Automated Research System (AI)