TROY TECHNICAL

POLYMERS & RESINS

WEEKLY REPORT

November 8 - November 14, 2026 | Issue 2026-W45

Qualification evidence across formulation, processing, durability and circularity

10	10
ANALYZED ARTICLES	PRIORITY THEMES

Issued 2026-11-14 | English edition | fixed approved cover artwork



Polymers & Resins: the boundary moved from isolated claims to qualification evidence

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

SIGNAL 01 | MOLECULE & FORMULATION

EOS Polymer Platform: FKM Reports 67% Productivity Gain

FKM reported that an unreleased EOS polymer AM platform shortened the build time of one in-house part from 3 h 10 min to 1 h 54 min, a reported 67% productivity gain. One part does not establish general throughput, part quality, or equipment economics.

SIGNAL 02 | MATERIAL PRODUCTION

LLNL NIF Targets: 2PP Printing Cuts CPC Production to One Day

LLNL used two-photon polymerization to make a NIF compound parabolic concentrator as one assembly, reducing this component's fabrication time from ten days to one. It was fielded in an April 2026 experiment.

SIGNAL 03 | PROCESSING

Mars Materials: Hoigen-C Carbon Fiber Precursor Specs and Validation

Mars Materials and NC State reported spinning a carbon-fiber precursor made from captured industrial emissions on standard commercial equipment.

SIGNAL 04 | COMPONENT ADOPTION

KAIST PEG-LCP Separator: Reducing Ion Path Tortuosity by 2.5x

KAIST's November 9 release reports about 2.5-fold lower lithium-ion path tortuosity than a horizontally aligned separator. The underlying paper appeared in September 2026; a lithium-metal cell retained 94% capacity after 100 cycles at 4C.

DECISION

Focus this week's management attention on qualification evidence across formulation, processing, durability and circularity. Move only when the linked evidence can be reproduced under your own operating conditions.

THREE MANAGEMENT MOVES

1. Buyers: select applications where performance data can justify qualification effort and switching cost.
2. Suppliers: provide process windows, reliability data, traceability and recovery economics with the material.
3. Executives: track scale, price, long-term reliability, regulation, recyclability and customer 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

67% A07	SOURCE-BOUND CONDITION FKM's one in-house part went from 3 h 10 min to 1 h 54 min on an unreleased EOS platform; general throughput is unproven.
10d→1d A06	SOURCE-BOUND CONDITION LLNL reduced fabrication of one NIF CPC component from ten days to one and fielded it in an April 2026 experiment.
2.5× A05	SOURCE-BOUND CONDITION KAIST reports ion-path tortuosity about 2.5-fold lower than a horizontally aligned separator.
~6 GPa A03	SOURCE-BOUND CONDITION Tensile strength of KIT's thermally converted, micro-scale silica-glass specimens; not a qualified production-part value.
9.2× A08	SOURCE-BOUND CONDITION PET-degrading enzyme activity under laboratory conditions; commercial plant throughput and economics remain untested.

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

Molecule & formulation

P01/P06

FKM reported that an unreleased EOS polymer AM platform shortened the build time of one in-house part from 3 h 10 min to 1 h.

2

Material production

P02/P07

LLNL used two-photon polymerization to make a NIF compound parabolic concentrator as one assembly, reducing this component's.

3

Processing

P03/P08

Mars Materials and NC State reported spinning a carbon-fibe r precursor made from captured industrial emissions on standard.

4

Component adoption

P04/P09

KAIST's November 9 release reports about 2.5-fold lower lithium-ion path tortuosity than a horizontally aligned separator.

5

Recovery & reuse

P05/P10

A KIT paper first published online on October 30, 2026 reports about 6 GPa tensile strength in micro-scale silica-glass.

EVIDENCE REQUIRED AT EACH HANDOFF

Molecule & formulation to Material production	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck scale, price, long-term reliability, regulation, recyclability and customer qualification.
Material production to Processing	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck scale, price, long-term reliability, regulation, recyclability and customer qualification.
Processing to Component adoption	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck scale, price, long-term reliability, regulation, recyclability and customer qualification.
Component adoption to Recovery & reuse	Transfer test conditions, acceptance criteria, failure data, owner and decision date. Recheck scale, price, long-term reliability, regulation, recyclability and customer qualification.

COMMON CONTROL POINT

No theme moves to a commercial commitment until a named owner has reproduced the relevant evidence and documented scale, price, long-term reliability, regulation, recyclability and customer qualification.

Priority map: maturity and next decision locus



P01	EOS Polymer Platform: FKM Reports 67% Productivity Gain System / adoption | cue: Platform
P02	LLNL NIF Targets: 2PP Printing Cuts CPC Production to One Day Tech / process | cue: no system/business cue
P03	Mars Materials: Hoigen-C Carbon Fiber Precursor Specs and Validation Business / rules | cue: standard
P04	KAIST PEG-LCP Separator: Reducing Ion Path Tortuosity by 2.5x Business / rules | cue: capacity
P05	KIT Silica Glass Nanoprints: 6 GPa Tensile Strength Specs Tech / process | cue: no system/business cue
P06	PET Plastic Recycling: Cutinase Enzyme Activity Boosted 9.2-Fold System / adoption | cue: commercial
P07	MXene-B4C-Polyimide: Specs for Cosmic Radiation and EMI Shielding System / adoption | cue: system
P08	[CMMIm][H2PO4]: Flame Retardancy and Mechanical Specs for EP Tech / process | cue: no system/business cue
P09	PU-S Elastomers: S-for-O Substitution for Room-Temperature Healing Tech / process | cue: no system/business cue
P10	UBNP-G Composite: Graphene-Driven Rapid Self-Healing and Sensing Tech / process | cue: no system/business cue

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 EOS Polymer Platform: FKM Reports 67% Productivity Gain

A07 | Molecule & formulation | Joint evaluation

2026-11-13

FACT

FKM reported that an unreleased EOS polymer AM platform shortened the build time of one in-house part from 3 h 10 min to 1 h 54 min, a reported 67% productivity gain. One part does not establish general throughput, part quality, or equipment economics.

WHY IT MATTERS

The decision relevance is qualification evidence across formulation, processing, durability and circularity. 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, provide process windows, reliability data, traceability and recovery economics with the material.

ACTION

Within 30 days, select applications where performance data can justify qualification effort and switching cost; record the evidence and owner against P01.

UNKNOWN

Still unproven or incompletely stated: scale, price, long-term reliability, regulation, recyclability and customer qualification.

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

P02 LLNL NIF Targets: 2PP Printing Cuts CPC Production to One Day

A06 | Material production | Fielded in experiment

2026-11-13

FACT

LLNL used two-photon polymerization to make a NIF compound parabolic concentrator as one assembly, reducing this component's fabrication time from ten days to one. It was fielded in an April 2026 experiment. The result applies to this component, not all fusion targets.

WHY IT MATTERS

The decision relevance is qualification evidence across formulation, processing, durability and circularity. 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, provide process windows, reliability data, traceability and recovery economics with the material.

ACTION

Within 30 days, select applications where performance data can justify qualification effort and switching cost; record the evidence and owner against P02.

UNKNOWN

Still unproven or incompletely stated: scale, price, long-term reliability, regulation, recyclability and customer qualification.

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

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

P03 Mars Materials: Hoigen-C Carbon Fiber Precursor Specs and Validation

A04 | Processing | Joint evaluation

2026-11-13

FACT

Mars Materials and NC State reported spinning a carbon-fiber precursor made from captured industrial emissions on standard commercial equipment. This demonstrates precursor process compatibility; it is not customer qualification of finished carbon fiber or composites.

WHY IT MATTERS

The decision relevance is qualification evidence across formulation, processing, durability and circularity. 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, provide process windows, reliability data, traceability and recovery economics with the material.

ACTION

Within 30 days, select applications where performance data can justify qualification effort and switching cost; record the evidence and owner against P03.

UNKNOWN

Still unproven or incompletely stated: scale, price, long-term reliability, regulation, recyclability and customer qualification.

EDITORIAL SCORE 21/25 | MATURITY 3/5 | DECISION LOCUS: BUSINESS / RULES

P04 KAIST PEG-LCP Separator: Reducing Ion Path Tortuosity by 2.5x

A05 | Component adoption | Pilot

2026-11-10

FACT

KAIST's November 9 release reports about 2.5-fold lower lithium-ion path tortuosity than a horizontally aligned separator. The underlying paper appeared in September 2026; a lithium-metal cell retained 94% capacity after 100 cycles at 4C. Long-life, large-area manufacturing remains unproven.

WHY IT MATTERS

The decision relevance is qualification evidence across formulation, processing, durability and circularity. 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, provide process windows, reliability data, traceability and recovery economics with the material.

ACTION

Within 30 days, select applications where performance data can justify qualification effort and switching cost; record the evidence and owner against P04.

UNKNOWN

Still unproven or incompletely stated: scale, price, long-term reliability, regulation, recyclability and customer qualification.

EDITORIAL SCORE 20/25 | MATURITY 2/5 | DECISION LOCUS: BUSINESS / RULES

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

P05 KIT Silica Glass Nanoprints: 6 GPa Tensile Strength Specs

A03 | Recovery & reuse | Pilot

Prior paper 2026-10-30

FACT

A KIT paper first published online on October 30, 2026 reports about 6 GPa tensile strength in micro-scale silica-glass specimens made by two-photon printing and thermolysis. This is a research result, not a qualified strength or yield for mass-produced parts.

WHY IT MATTERS

The decision relevance is qualification evidence across formulation, processing, durability and circularity. 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, provide process windows, reliability data, traceability and recovery economics with the material.

ACTION

Within 30 days, select applications where performance data can justify qualification effort and switching cost; record the evidence and owner against P05.

UNKNOWN

Still unproven or incompletely stated: scale, price, long-term reliability, regulation, recyclability and customer qualification.

EDITORIAL SCORE 20/25 | MATURITY 2/5 | DECISION LOCUS: TECH / PROCESS

P06 PET Plastic Recycling: Cutinase Enzyme Activity Boosted 9.2-Fold

A08 | Molecule & formulation | Pilot

2026-11-10

FACT

A King's College London and Rutgers study reports 9.2-fold higher PET-degrading enzyme activity under its laboratory conditions. Degradation speed and economics for mixed, contaminated post-consumer PET in a commercial plant need separate validation.

WHY IT MATTERS

The decision relevance is qualification evidence across formulation, processing, durability and circularity. 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, provide process windows, reliability data, traceability and recovery economics with the material.

ACTION

Within 30 days, select applications where performance data can justify qualification effort and switching cost; record the evidence and owner against P06.

UNKNOWN

Still unproven or incompletely stated: scale, price, long-term reliability, regulation, recyclability and customer qualification.

EDITORIAL SCORE 20/25 | MATURITY 2/5 | DECISION LOCUS: SYSTEM / ADOPTION

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

P07 MXene-B4C-Polyimide: Specs for Cosmic Radiation and EMI Shielding

A01 | Material production | Research

2026-11-12

FACT

A lightweight nanocomposite combining MXene (Ti3C2Tx), B4C, and polyimide achieves 100% proton attenuation and 54.7 dB EMI shielding in the X-band. This dual-function material reduces areal mass by approximately 81% compared to a 2.0 mm aluminum reference, offering a consolidated protection system for aerospace avionics.

WHY IT MATTERS

The decision relevance is qualification evidence across formulation, processing, durability and circularity. 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, provide process windows, reliability data, traceability and recovery economics with the material.

ACTION

Within 30 days, select applications where performance data can justify qualification effort and switching cost; record the evidence and owner against P07.

UNKNOWN

Still unproven or incompletely stated: scale, price, long-term reliability, regulation, recyclability and customer qualification.

EDITORIAL SCORE 19/25 | MATURITY 1/5 | DECISION LOCUS: SYSTEM / ADOPTION

P08 [CMMIm][H2PO4]: Flame Retardancy and Mechanical Specs for EP

A02 | Processing | Research

2026-11-11

FACT

A phosphorus-nitrogen synergistic imidazolium ionic liquid, [CMMIm][H2PO4], significantly enhances the fire resistance and mechanical properties of epoxy resin (EP). The modifier reduced the peak heat release rate (PHRR) by approximately 39% and increased the limiting oxygen index (LOI) to 30.68%. This approach addresses the traditional trade-off between flame retardancy and mechanical strength in engineering resins.

WHY IT MATTERS

The decision relevance is qualification evidence across formulation, processing, durability and circularity. 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, provide process windows, reliability data, traceability and recovery economics with the material.

ACTION

Within 30 days, select applications where performance data can justify qualification effort and switching cost; record the evidence and owner against P08.

UNKNOWN

Still unproven or incompletely stated: scale, price, long-term reliability, regulation, recyclability and customer qualification.

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

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

P09 PU-S Elastomers: S-for-O Substitution for Room-Temperature Healing

A09 | Component adoption | Pilot

2026-11-10

FACT

Researchers from South China University of Technology developed a PU-S elastomer that achieves a 92% toughness recovery rate at room temperature without external stimuli. By replacing urea chain extenders with thiourea units, the material balances high tensile strength (23.7 MPa) with rapid self-healing. This molecular design provides a sustainable pathway for high-performance flexible materials and flexible electronics.

WHY IT MATTERS

The decision relevance is qualification evidence across formulation, processing, durability and circularity. 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, provide process windows, reliability data, traceability and recovery economics with the material.

ACTION

Within 30 days, select applications where performance data can justify qualification effort and switching cost; record the evidence and owner against P09.

UNKNOWN

Still unproven or incompletely stated: scale, price, long-term reliability, regulation, recyclability and customer qualification.

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

P10 UBNP-G Composite: Graphene-Driven Rapid Self-Healing and Sensing

A10 | Recovery & reuse | Pilot

2026-11-08

FACT

Researchers reported repair of a graphene-polymer composite in about 40 seconds using externally supplied electrical current for Joule heating, alongside damage sensing. The 40-second result is an energized laboratory condition, not autonomous room-temperature repair.

WHY IT MATTERS

The decision relevance is qualification evidence across formulation, processing, durability and circularity. 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, provide process windows, reliability data, traceability and recovery economics with the material.

ACTION

Within 30 days, select applications where performance data can justify qualification effort and switching cost; record the evidence and owner against P10.

UNKNOWN

Still unproven or incompletely stated: scale, price, long-term reliability, regulation, recyclability and customer qualification.

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

Playbook and 0-5 year roadmap

STAKEHOLDER	NOW | 0-30 DAYS	NEXT | 1-12 MONTHS	LATER | 1-5 YEARS
Operating companies	select applications where performance data can justify qualification effort and switching cost	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	provide process windows, reliability data, traceability and recovery economics with the material	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 scale, price, long-term reliability, regulation, recyclability and customer 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 01-10

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	MXene-B4C-Polyimide: Specs for Cosmic Radiation and EMI Shielding	https://doi.org/10.21203/rs.3.rs-10946351/v1
A02	[CMMIm][H2PO4]: Flame Retardancy and Mechanical Specs for EP	https://doi.org/10.21203/rs.3.rs-11314870/v1
A03	KIT Silica Glass Nanoprints: 6 GPa Tensile Strength Specs	https://3dprintingindustry.com/news/kit-turns-rubber-like-3d-nanoprints-into-record-6-gpa-silica-glass-256373/
A04	Mars Materials: Hoigen-C Carbon Fiber Precursor Specs and Validation	https://www.compositesworld.com/news/mars-materials-nc-state-university-successfully-convert-industrial-pollution-into-precursor
A05	KAIST PEG-LCP Separator: Reducing Ion Path Tortuosity by 2.5x	https://xenospectrum.com/en/kaist-liquid-crystal-polymer-separator-lithium-metal-battery/
A06	LLNL NIF Targets: 2PP Printing Cuts CPC Production to One Day	https://3dprintingindustry.com/news/llnl-cuts-nif-target-component-production-from-ten-days-to-one-with-two-photon-polymerization-256578/
A07	EOS Polymer Platform: FKM Reports 67% Productivity Gain	https://3dprintingindustry.com/news/fkm-tests-unreleased-eos-polymer-platform-reports-67-productivity-gain-on-in-house-part-256498/
A08	PET Plastic Recycling: Cutinase Enzyme Activity Boosted 9.2-Fold	https://www.miragenews.com/new-approach-makes-plastic-eating-enzyme-nearly-1774794/
A09	PU-S Elastomers: S-for-O Substitution for Room-Temperature Healing	https://www.miragenews.com/sulfur-for-oxygen-substitution-boosts-self-1774522/
A10	UBNP-G Composite: Graphene-Driven Rapid Self-Healing and Sensing	https://bioengineer.org/graphene-networks-give-self-healing-polymers-rapid-joule-heated-repair-and-damage-sensing/

Polymers_Resins — Selected Articles

Date: 2026-11-15

Articles: 10

Table of Contents

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#08 PET Plastic Recycling: Cutinase Enzyme Activity Boosted 9.2-Fold

#09 PU-S Elastomers: S-for-O Substitution for Room-Temperature Healing

#10 UBNP-G Composite: Graphene-Driven Rapid Self-Healing and Sensing

#01 MXene–B_4C–Polyimide: Specs for Cosmic Radiation and EMI Shielding

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



OVERVIEW

A lightweight nanocomposite combining MXene ($Ti_3C_2T_x$), B_4C, and polyimide achieves 100% proton attenuation and 54.7 dB EMI shielding in the X-band. This dual-function material reduces areal mass by approximately 81% compared to a 2.0 mm aluminum reference, offering a consolidated protection system for aerospace avionics.

IN DEPTH

Key Findings

The optimized MXene–B_4C–polyimide nanocomposite achieves 100% attenuation of 50 MeV protons at a bulk thickness of 36 mm, a performance approximately fivefold higher than aerospace-grade aluminum. Simultaneously, the material provides 54.7 dB of electromagnetic interference (EMI) shielding across the X-band (8.2–12.4 GHz). These results are achieved with an areal mass reduction of approximately 81% relative to a 2.0 mm aluminum reference.

Technical Details

The material's composition was guided by SRIM/TRIM simulations, which indicated that a boron-rich composition of 31 at% allows for the complete stopping of 50 MeV protons at 36 mm thickness, with electronic stopping as the dominant energy loss mechanism. The fabrication process utilizes solution casting and vacuum-assisted filtration to incorporate exfoliated MXene nanosheets and surface-functionalized B_4C nanoparticles (~ 45 nm).

- **Composition:** 20 wt% B_4C and 15 wt% MXene.
- **Electrical Conductivity:** 2.1 × 10^4 S/m.
- **Mechanical Properties:** Retains flexibility down to a 2 mm bend radius.
- **Environmental Durability:** Performance is retained after 1,000 h of humidity exposure and 500 thermal cycles, aligned with RTCA DO-160G tests.

Background and Context

Flight-critical avionics at cruise altitudes are simultaneously threatened by atmospheric proton radiation and EMI. Traditional protection requires separate components: aluminum- or lead-based barriers for radiation and conductive copper-mesh shields for EMI. This fragmented approach increases the total mass, volume, and integration complexity of avionics enclosures.

Significance and Outlook

By integrating proton attenuation and EMI shielding into a single conformal material, this nanocomposite reduces the need for multiple heavy shielding layers. MCNP6.2 simulations project that this system can provide an eightfold reduction in processor radiation dose. The balance of mass efficiency, flexibility, and shielding effectiveness supports the development of lightweight, multifunctional protection for aerospace electronics.

Source: https://doi.org/10.21203/rs.3.rs-10946351/v1

Collected: November 15, 2026 | Automated Research System (AI)

#02 [CMMIm][H2PO4]: Flame Retardancy and Mechanical Specs for EP

Published November 11, 2026　Research Square（プレプリント）



OVERVIEW

A phosphorus-nitrogen synergistic imidazolium ionic liquid, [CMMIm][H2PO4], significantly enhances the fire resistance and mechanical properties of epoxy resin (EP). The modifier reduced the peak heat release rate (PHRR) by approximately 39% and increased the limiting oxygen index (LOI) to 30.68%. This approach addresses the traditional trade-off between flame retardancy and mechanical strength in engineering resins.

IN DEPTH

Key Findings

The introduction of 1-(carbamoylmethyl)-2-methylimidazolium dihydrogen phosphate ([CMMIm][H2PO4]) as a multifunctional modifier significantly improves the fire resistance of epoxy resin. In the EP-4 sample, the LOI value increased from 20.41% to 30.68%. Furthermore, the PHRR value decreased from 923.43 $kW \cdot m^{-2}$ to 563.61 $kW \cdot m^{-2}$, representing a reduction of approximately 39%.

Technical Details

Researchers utilized LOI, TGA, the cone calorimeter method, Raman spectroscopy, scanning electron microscope (SEM), and mechanical tests to evaluate the modifier's impact. Thermal analysis at 800°C showed that the carbonized residue content increased from 11.64% to 16.90%. Raman spectroscopy indicated a more stable carbonization structure, as the ID/IG ratio decreased from 0.85 to 0.78.

Mechanical testing of the EP-4 variant demonstrated the following properties:

- Tensile strength: 73.91 MPa
- Bending modulus: 3522.38 MPa
- Impact strength: 16.75 $kJ \cdot m^{-2}$

Background & Context

Epoxy resin is widely utilized across various engineering applications due to its versatility. However, the material possesses inherent flammability. A persistent challenge for engineers and material scientists has been balancing the addition of flame retardants with the maintenance or improvement of the resin's mechanical properties, as many additives typically degrade structural integrity.

Significance & Outlook

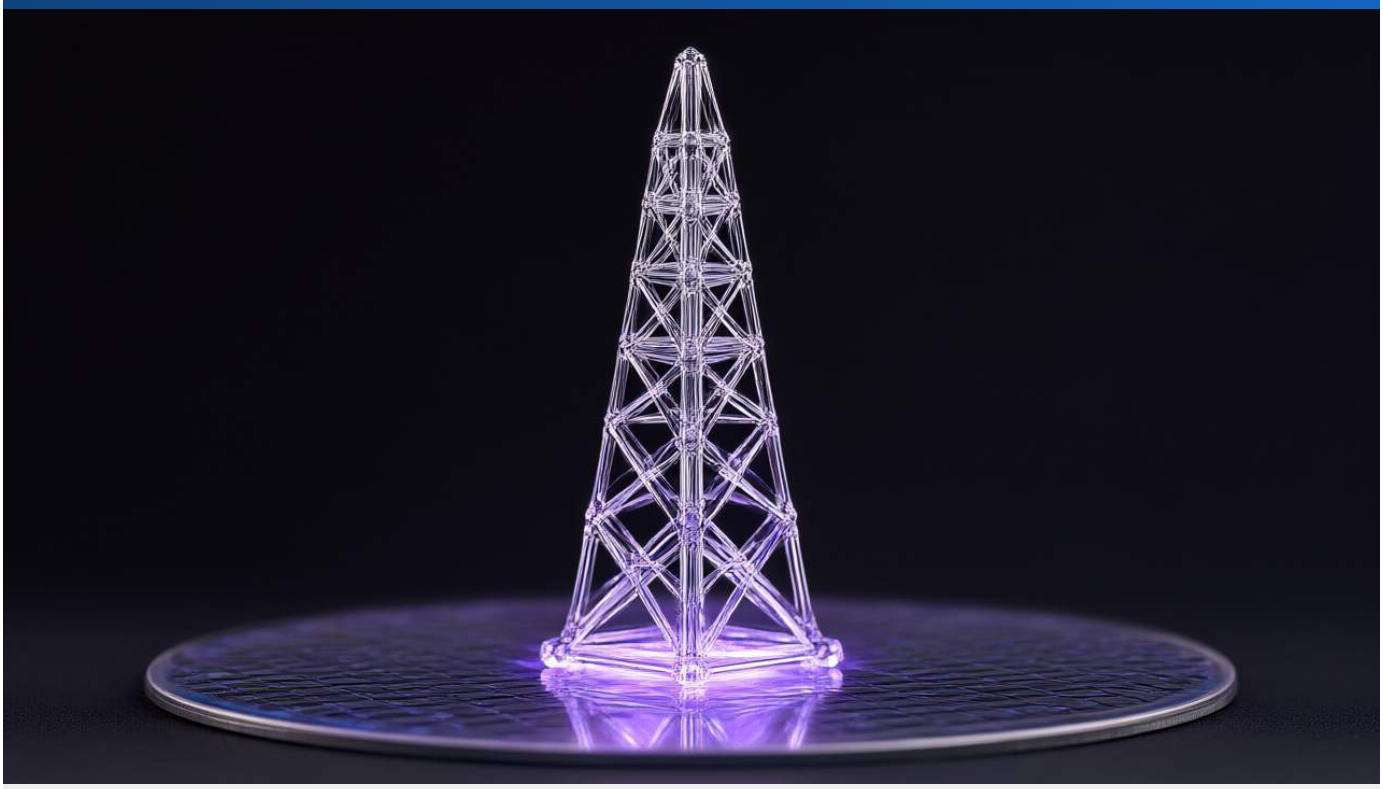
The synthesis of the amide-functionalized imidazoline ionic liquid [CMMIm][H2PO4] provides an effective strategy for modifying epoxy resin. By simultaneously enhancing flame retardancy and improving mechanical performance, this phosphorus-nitrogen synergistic approach offers a viable solution for high-performance engineering applications requiring strict fire safety standards without sacrificing structural strength.

Source: https://doi.org/10.21203/rs.3.rs-11314870/v1

Collected: November 15, 2026 | Automated Research System (AI)

#03 KIT Silica Glass Nanoprints: 6 GPa Tensile Strength Specs

Published November 10, 2026 3D Printing Industry Germany



OVERVIEW

Researchers at the Karlsruhe Institute of Technology (KIT) have achieved a record tensile strength of 5.94 ± 0.45 GPa for silica glass produced via two-photon polymerization (2PP) 3D printing. By mapping the thermolysis conversion from a rubber-like polymer to glass, the team established a framework for high-fidelity precision structures. This advancement enables the creation of micro-optics and microsystems with mechanical properties exceeding those of commercial glass fibers.

IN DEPTH

Key Findings

The study reports a record tensile strength of 5.94 ± 0.45 GPa for 3D nanoprinted silica glass when heated to 1000°C, with a modulus of approximately 77 GPa. These values roughly triple the strength of pyrolytic carbon and exceed the strongest commercial glass fibers. The researchers successfully mapped the transition of the material from a rubber-like hybrid polymer to a brittle, transparent glass through a controlled heat treatment process.

Technical Details

The team utilized a Nanoscribe Photonic Professional GT2 to print parts using a resin based on polyhedral oligomeric silsesquioxane (POSS), combined with an acrylate from Sartomer and a photoinitiator. The conversion process followed these stages:

- **Untreated:** Rubber-like behavior with 129 MPa tensile strength and over 60% elongation.
- **300°C:** Increased stiffness and strength (4 to 6 times) due to heat-driven crosslinking.
- **440°C:** Material became brittle and ceramic-like; tensile strength reached the gigapascal range, while elongation dropped to about 9%.
- **700°C to 1000°C:** Tensile strength rose from 4.17 ± 0.46 GPa to 5.94 ± 0.45 GPa.

Infrared spectroscopy confirmed that the silica network became the main load-bearer at 440°C, with a dense fused silica spectrum appearing after 700°C. This network formed more than 500°C below the melting point of SiO_2. Mass loss stabilized above 600°C, with a remaining mass of approximately 32%.

Background & Context

While 2PP is a leading method for small-scale polymer printing, converting these prints to glass often relies on empirical heating schedules. Previous methods include the 2021 University of Freiburg approach using Glassomer (silica nanoparticles in a binder) and a 2018 Vilnius University process using SZ2080 to create glass-ceramics via sintering at 1500°C. Unlike these nanoparticle-based routes, the KIT method converts molecular POSS cages.

Significance & Outlook

The ability to stop heat treatment at specific intervals allows for the tuning of stiffness and strength across two orders of magnitude. This flexibility is particularly useful for microsystems containing temperature-sensitive components, such as conductive aluminum layers. The study concludes that a self-supporting inorganic network must form before the organic framework breaks down to ensure high-fidelity precision.

Source: https://3dprintingindustry.com/news/kit-turns-rubber-like-3d-nanoprints-into-record-6-gpa-silica-glass-256373/

Collected: November 15, 2026 | Automated Research System (AI)

#04 Mars Materials: Hoigen-C Carbon Fiber Precursor Specs and Validation

Published November 13, 2026 CompositesWorld USA



OVERVIEW

Mars Materials and NC State University have demonstrated that Hoigen-C, a precursor derived from captured industrial pollution, can be spun into carbon fiber precursor using standard commercial equipment. The material achieves tensile strength and modulus targets equivalent to industry-standard PAN, offering a non-toxic, sustainable alternative to petroleum-based production.

IN DEPTH

Key Findings

Mars Materials Inc. (MM) and North Carolina State University (NC State) have successfully converted Hoigen-C into a polymer and spun it directly into a carbon fiber precursor. Performance testing conducted by NC State's Wilson College of Textiles confirms that the fiber meets tensile strength and modulus targets consistent with industry-standard polyacrylonitrile (PAN) precursors.

Technical Details

The production process utilizes captured pollution from industrial emitters as the raw material source. Funded by the Textile Innovation Engine, the research team demonstrated that Hoigen-C serves as a "drop-in" replacement, meaning it can be processed using existing commercial equipment without requiring manufacturers to invest in new machinery or alter current operations. Unlike traditional PAN manufacturing, the Hoigen-C route eliminates the use of petroleum and the production of hazardous byproducts such as hydrogen cyanide.

Background and Context

The carbon fiber supply chain currently faces vulnerabilities due to a decline in U.S. production, leaving the global supply dominated by foreign competitors. Traditional precursor manufacturing is characterized by high toxicity and complexity. By utilizing a sustainable production route that removes deadly chemicals, Mars Materials aims to reduce the complexity and cost of manufacturing while improving safety.

Significance and Outlook

Because the resulting textile is cleaner and free of toxic byproducts, it can be fine-tuned for a wide range of high-performance composite applications. Potential use cases include:

- Military aircraft and drones
- Combat vehicles
- Race cars and motorsports
- Cores for electric power grids

This advancement addresses the strategic dependence of American manufacturers on foreign raw materials by providing a domestic, safer, and more sustainable precursor source.

Source: https://www.compositesworld.com/news/mars-materials-nc-state-university-successfully-convert-industrial-pollution-into-precursor

Collected: November 15, 2026 | Automated Research System (AI)

#05 KAIST PEG-LCP Separator: Reducing Ion Path Tortuosity by 2.5x

Published November 10, 2026 XenoSpectrum South Korea



OVERVIEW

Researchers at KAIST have developed a liquid crystal polymer (PEG-LCP) separator that reduces lithium-ion path tortuosity to approximately one-2.5th of horizontally aligned films. By orienting nanopores perpendicular to the electrode surface, the team improved ion transport efficiency and suppressed dendrite growth in lithium-metal batteries.

IN DEPTH

Key Findings

A joint research team led by Professors Dong Ki Yoon and Hye Ryungon Byon at KAIST has demonstrated that controlling the molecular alignment of a liquid crystal polymer separator significantly reduces the resistance encountered by lithium ions. The team found that vertical alignment of nanopores reduces the effective tortuosity of the ion pathway to about one-2.5th compared to planar (horizontal) alignment. This structural optimization results in an ionic conductivity of 1.77 mS/cm in a carbonate-based electrolyte and a low activation energy of 0.12 eV for ion migration.

Technical Details

The researchers synthesized liquid crystal molecules incorporating polyethylene glycol (PEG) chains to facilitate ion transport via coordination interactions. These molecules were cross-linked and fixed to create a PEG-LCP membrane with nanopore channels approximately 19 nm in diameter. The study compared two configurations with equivalent chemical compositions and pore structures:

- **Planar alignment:** Channels run parallel to the film surface.
- **Homeotropic alignment:** Channels are aligned through the film thickness, perpendicular to the electrode surface.

The vertical alignment acts as a "highway," providing a more direct transport path for lithium ions moving between electrodes.

Background and Context

Conventional lithium-ion batteries use polyolefin microporous membranes with winding paths, characterized by high tortuosity. In lithium-metal batteries, uneven ion supply during fast charging often leads to the growth of "dendrites"—tree-like metallic lithium crystals—which can cause internal short circuits and battery degradation. The KAIST study, published in *ACS Nano* (Volume 20, Issue 40), focuses on using molecular alignment as an independent control element to ensure a more uniform ion supply.

Significance and Outlook

The results indicate that vertical alignment improves the deposition of metallic lithium and suppresses dendritic and porous growth. While this laboratory-scale proof of principle demonstrates that ion transport can be improved via alignment rather than solely through new chemical compositions, the researchers note that risks of side reactions and internal short circuits have not been fundamentally eliminated.

Source: https://xenospectrum.com/en/kaist-liquid-crystal-polymer-separator-lithium-metal-battery/

Collected: November 15, 2026 | Automated Research System (AI)

#06 LLNL NIF Targets: 2PP Printing Cuts CPC Production to One Day

Published November 13, 2026 3D Printing Industry USA



OVERVIEW

Lawrence Livermore National Laboratory (LLNL) has reduced the production time of compound parabolic concentrators (CPCs) for the National Ignition Facility (NIF) from ten days to one using two-photon polymerization (2PP). This laser-based additive manufacturing process enables single-piece printing of micron-scale components, expanding design possibilities for high-energy-density physics experiments.

IN DEPTH

Key Findings

LLNL has successfully implemented two-photon polymerization (2PP) to fabricate compound parabolic concentrators (CPCs) for NIF targets, reducing production time from ten days to one. Unlike previous additive manufacturing attempts that struggled with feature size and surface roughness, 2PP allows the CPC to be printed as a single assembly without requiring a gold coating. A 2PP-printed CPC was first fielded in April 2026 for diagnostic calibration and later used in a September 2026 Discovery Science campaign on ion fast ignition.

Technical Details

The CPC is a critical component that guides X-ray sources onto fuel capsules for diagnostic measurements; its narrow end measures 20 microns across, and the overall part is approximately 1.5 millimeters in size. The traditional fabrication process involved diamond turning a copper mandrel, coating it with gold and plastic, machining the final form, dissolving the mandrel, and attaching the cone to a support structure.

In contrast, 2PP utilizes a high-intensity laser focused to a spot smaller than one micron to enable simultaneous absorption of two photons. This precision allowed the team to create a CPC with an outer profile tailored to fit inside a gold cone via guide rails and glue. Additionally, 2PP was used to print a re-entrant cone with off-axis geometry that would have been difficult to produce via diamond turning, specifically to prevent laser backscatter into beamlines.

Background and Context

NIF components must undergo rigorous testing at the Jupiter Laser Facility and the University of Rochester’s Laboratory for Laser Energetics to ensure they do not damage optics or compromise national security data. Parallel research by the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) and Vilnius University also utilized 2PP to create 500 μm-wide log-pile lattices with 14 μm struts to study ablation speeds and laser-scattering in inertial confinement fusion (ICF) designs.

Significance and Outlook

The adoption of 2PP removes a significant fabrication bottleneck for micron-scale fusion target components. LLNL engineers are now exploring the production of other parts, including fuel capsules featuring lattice structures to hold wetted foams for new fuel layer formation approaches.

Source: https://3dprintingindustry.com/news/llnl-cuts-nif-target-component-production-from-ten-days-to-one-with-two-photon-polymerization-256578/

Collected: November 15, 2026 | Automated Research System (AI)

#07 EOS Polymer Platform: FKM Reports 67% Productivity Gain

Published November 13, 2026 3D Printing Industry USA



OVERVIEW

FKM Additive Manufacturing achieved a 67% productivity increase using an unreleased EOS polymer additive manufacturing platform. Build time for a specific in-house component dropped from 3 hours 10 minutes to 1 hour 54 minutes, demonstrating improved machine utilization for series production.

IN DEPTH

Key Findings

FKM Additive Manufacturing reports a 67% increase in productivity when testing an upcoming polymer additive manufacturing platform from EOS. In a specific application involving an in-house part, the build time per component was reduced from 3 hours 10 minutes to 1 hour 54 minutes compared to the contract manufacturer's previous equipment. This improvement allows FKM to complete a full build job every day within a single-shift operation.

Technical Details

The platform was tested using a powder dispenser with a diverter flap, a component designed in-house for FKM's automated powder handling system. Beyond speed, the system demonstrated significant improvements in dimensional accuracy, which EOS states directly enhanced the part's function. Technical features of the platform include:

- Adjustable parameters for surface quality, detail resolution, and mechanical properties.
- Stable and homogeneous process conditions to ensure reproducible part properties regardless of position in the build chamber.
- Reduced post-processing effort for functional parts.

Background and Context

FKM specializes in additive series production, prioritizing repeatability and planning reliability. The company notes that consistent quality is critical whether batches are produced weeks or years apart. EOS is following an industry pattern of using service bureaus as pre-launch test sites to generate production data. A similar approach was previously taken by Formlabs with its Fuse X1 system, where early access users, including Autotiv Manufacturing, provided throughput data prior to the official launch.

Significance and Outlook

For contract manufacturers, these productivity gains enable meeting increased demand without proportional expansions in floor space or machine capacity. The improved dimensional accuracy also facilitates the creation of future part variants without additional design effort. EOS will officially launch the platform on November 17, 2026, at 11:00 AM at Formnext 2026 (Hall 12, Booth D71), where full details of the system will be shared.

Source: https://3dprintingindustry.com/news/fkm-tests-unreleased-eos-polymer-platform-reports-67-productivity-gain-on-in-house-part-256498/

Collected: November 15, 2026 | Automated Research System (AI)

#08 PET Plastic Recycling: Cutinase Enzyme Activity Boosted 9.2-Fold

Published November 10, 2026 Mirage News（King's College London） UK



OVERVIEW

Researchers from King's College London and Rutgers University have developed a method to increase the activity of the plastic-eating enzyme cutinase by 9.2 times. By combining surface modification with a specific ionic liquid, the system maintains a consistent breakdown rate for at least seven days, enabling the recovery of pure terephthalic acid.

IN DEPTH

Key Findings

The modified enzyme system demonstrated a 9.2-fold increase in the speed of breaking chemical links in polyethylene terephthalate (PET) plastic compared to unmodified enzymes in water. Over the course of experiments, the modified system carried out approximately 9.5 times as many chemical reactions. While unmodified enzymes lost substantial activity after the first day (lasting around 36 hours), the modified approach maintained a steady breakdown rate for at least seven days.

Technical Details

The researchers utilized cutinase, a naturally occurring enzyme, and applied chemical changes to its surface to protect it against heat and chemical conditions. This modified enzyme was paired with an ionic liquid, which serves two primary functions: it loosens the tightly packed structure of PET to make chemical links more accessible and allows the reaction to occur at high temperatures where PET is more susceptible to breakdown.

- **Material Compatibility:** The method worked on flakes from used drinks bottles without requiring pre-heating or preparation.
- **Recovery:** The team recovered 97.1% of the ionic liquid for continuous reuse and isolated terephthalic acid as a pure powder.
- **Current Limitation:** The enzyme stopped working effectively after the recovery process; improving enzyme recovery remains a primary goal.

Background & Context

PET is widely used in clothing, food packaging, and bottles. While mechanical recycling via melting is common, repeated processing degrades plastic quality. Enzymatic recycling offers an alternative by breaking plastic down into original chemical building blocks to create new plastic, reducing reliance on fossil fuel-derived raw materials.

Significance & Outlook

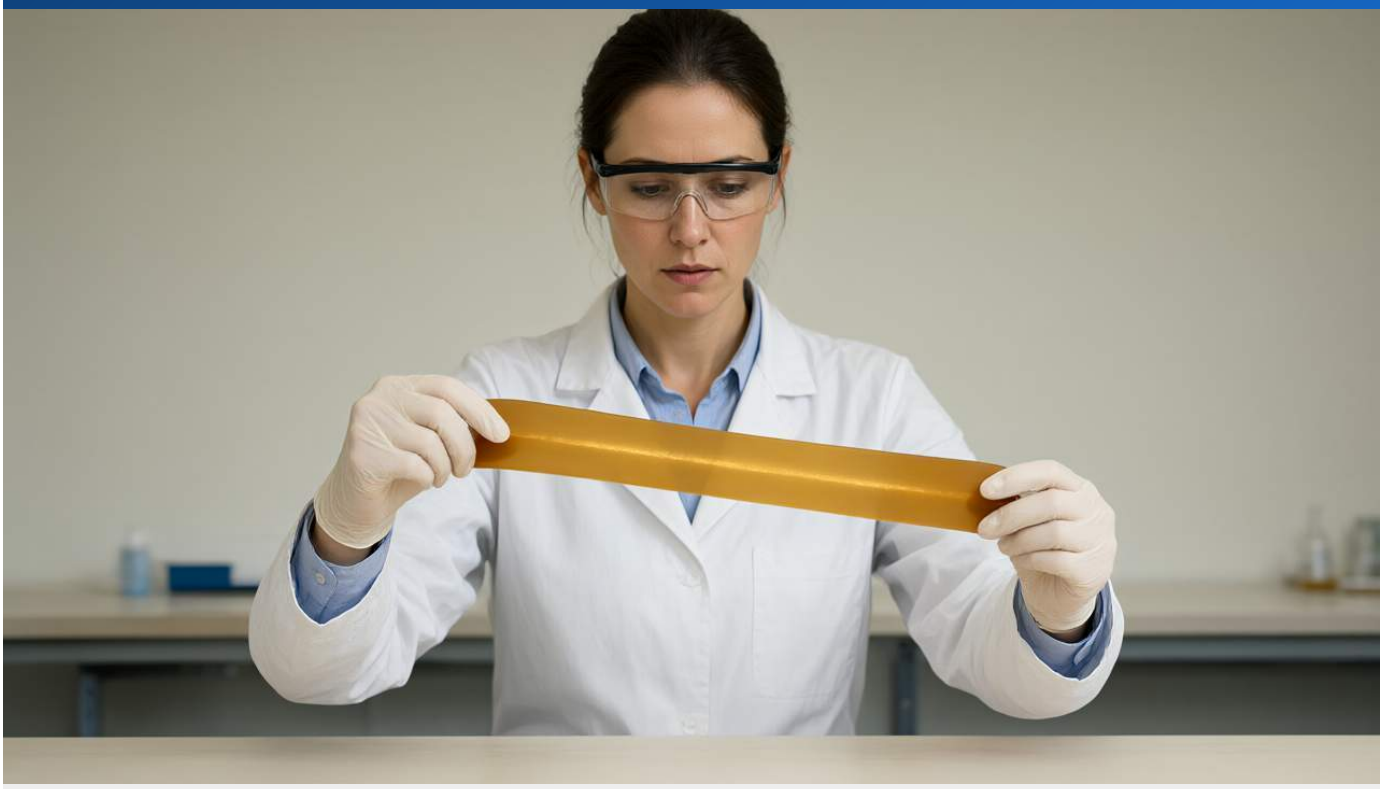
The researchers estimate that applying this approach to advanced, engineered enzymes could reduce the time for near-complete PET breakdown from approximately two days to five hours. Future work will focus on industrial scaling, specifically regarding energy requirements, environmental performance, and the recovery of the enzyme to further reduce material costs.

Source: https://www.miragenews.com/new-approach-makes-plastic-eating-enzyme-nearly-1774794/

Collected: November 15, 2026 | Automated Research System (AI)

#09 PU-S Elastomers: S-for-O Substitution for Room-Temperature Healing

Published November 10, 2026 Mirage News（Chinese Chemical Society） China



OVERVIEW

Researchers from South China University of Technology developed a PU-S elastomer that achieves a 92% toughness recovery rate at room temperature without external stimuli. By replacing urea chain extenders with thiourea units, the material balances high tensile strength (23.7 MPa) with rapid self-healing. This molecular design provides a sustainable pathway for high-performance flexible materials and flexible electronics.

IN DEPTH

Key Findings

The PU-S elastomer achieves a tensile strength of 23.7 MPa and an elongation at break of 1080%, while maintaining a toughness recovery efficiency of 92% after 24 hours of healing at 25 °C. In contrast, the control sample (PU-O) achieved only 27% healing efficiency under the same conditions, increasing to 52% only after heating to 50 °C. Additionally, the material demonstrates high recyclability, retaining approximately 90% of its tensile strength after three recycling cycles.

Technical Details

The "S-for-O" substitution strategy replaces traditional urea chain extenders (CH_2) with sulfur-containing thiourea analogues (TCH_2). Due to the larger atomic radius and lower electronegativity of sulfur, this substitution creates a disordered, asymmetric multi-point hydrogen bond network, preventing the formation of highly crystalline hard domains. Key technical evidence includes:

- **Hydrogen Bond Dynamics:** FT-IR spectroscopy shows the proportion of hydrogen-bonded carbonyl groups in PU-S decreased to 60.8%, compared to 75.7% in PU-O.
- **Activation Energy:** Stress relaxation experiments reveal an activation energy of 41.8 kJ/mol for PU-S, significantly lower than the 106.7 kJ/mol found in PU-O.
- **Binding Energy:** DFT calculations indicate the binding energy of the thiourea-thiourea (TCH-TCH) dimer is -13.05 kcal/mol, less than half that of the urea-urea (CH-CH) dimer (-29.61 kcal/mol).
- **Rheology:** At 25 °C, G' and G" of PU-S cross over in the low-frequency region, confirming dynamic hydrogen bond exchange.

Background & Context

Polyurethane (PU) elastomers are valued for their tunable hard-soft segment structures, making them recyclable alternatives to bulk plastics. However, a contradiction exists: high strength typically requires dense, strong hydrogen bonds that create rigid microdomains, which restrict the chain segment migration necessary for room-temperature self-healing. Most high-strength PU elastomers therefore require external stimuli to heal.

Significance & Outlook

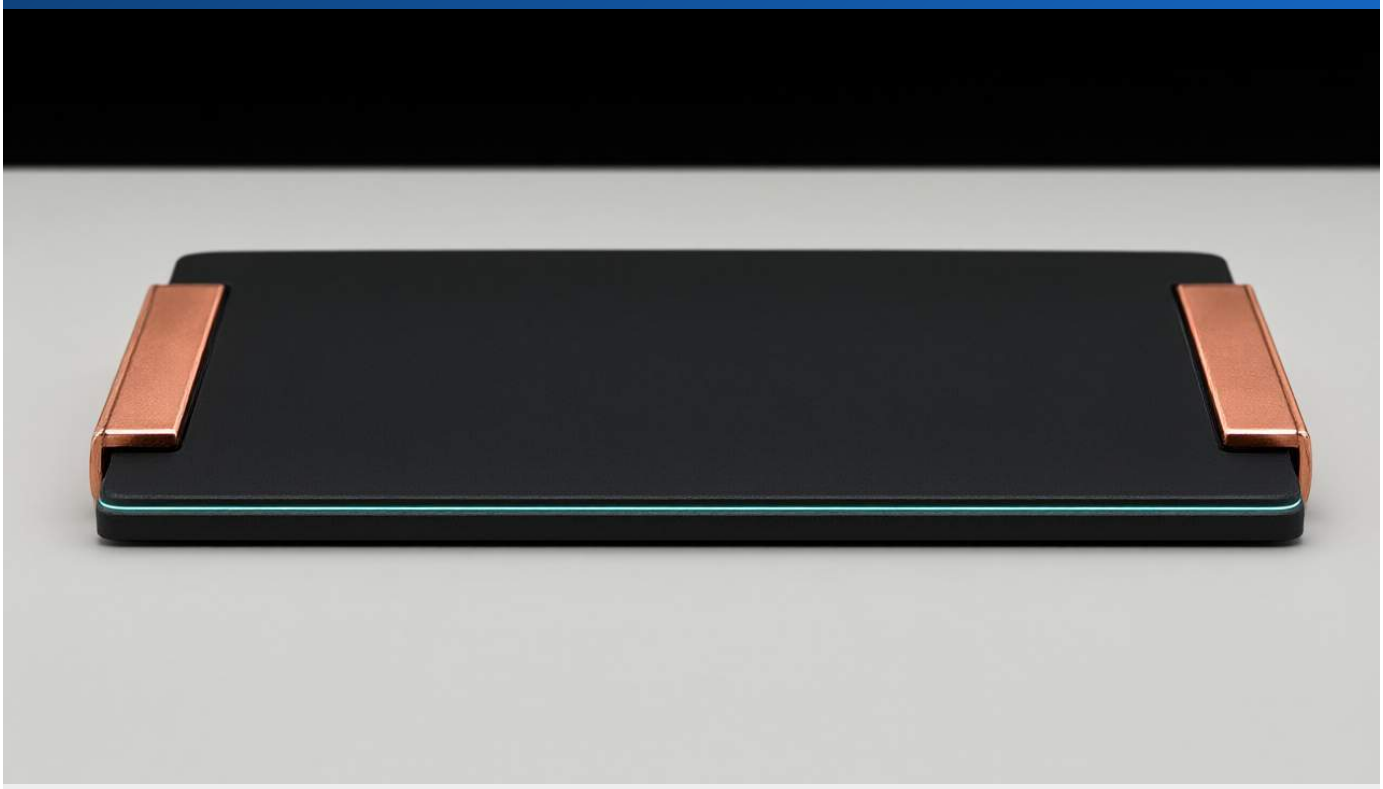
By regulating hydrogen bond dynamics through molecular design, this research overcomes the bottleneck of traditional high-strength elastomers. The ability to achieve high mechanical properties and rapid, stimulus-free healing at room temperature provides new insights for the development of sustainable, high-performance flexible electronics.

Source: https://www.miragenews.com/sulfur-for-oxygen-substitution-boosts-self-1774522/

Collected: November 15, 2026 | Automated Research System (AI)

#10 UBNP-G Composite: Graphene-Driven Rapid Self-Healing and Sensing

Published November 08, 2026 BIOENGINEER.ORG USA



OVERVIEW

A graphene-based polymer composite can achieve self-healing in approximately 40 seconds using electrical current via Joule heating. By utilizing a segregated conductive network, the material enables both rapid repair and integrated damage sensing across diverse temperatures.

IN DEPTH

Key Findings

Researchers have developed a graphene-based polymer composite, abbreviated as UBNP-G, capable of self-healing in roughly 40 seconds. Unlike conventional thermally activated polymers that rely on inefficient external convection, this material uses electrical current to generate internal Joule heating. This mechanism allows for rapid repair at both room temperature and extremely low temperatures without external heat sources.

Technical Details

The composite consists of graphene fillers combined with a ureidopyrimidinone-functionalized poly(ε-caprolactone) supramolecular polymer. The high performance is attributed to a segregated conductive network formed by the interaction between the two-dimensional geometry of graphene and dynamic supramolecular interactions. This architecture results in electrical conductivity 10^2 to 10^4 times higher than comparable composites using one-dimensional carbon nanotubes at equivalent filler loadings.

Molecular dynamics simulations were used to confirm that distinct filler–polymer interactions drive the phase separation required to concentrate conductive pathways. Additionally, the material serves as its own damage sensor; monitoring electrical resistance provides a reliable measure of structural damage and subsequent recovery, as breaks in the network register as resistance changes.

Background & Context

Traditional self-healing polymers often require lengthy recovery times due to the inefficiency of external heating. To solve this, the researchers integrated a percolated conductive filler network directly into the polymer matrix. The study highlights the importance of filler shape, noting that while one-dimensional fillers remain randomly dispersed, two-dimensional graphene drives the phase separation necessary for efficient electrothermal conversion.

Significance & Outlook

The UBNP-G composite provides a multifunctional strategy for structural health monitoring and repair. Because a single filler system handles Joule heating, sensing, and mechanical integration, it is suitable for demanding environments where ambient heat is unavailable. While these findings currently describe laboratory performance, the combination of seconds-scale healing and resistance-based detection represents a step toward autonomous composites for diverse environmental conditions.

Source: https://bioengineer.org/graphene-networks-give-self-healing-polymers-rapid-joule-heated-repair-and-damage-sensing/

Collected: November 15, 2026 | Automated Research System (AI)