

Fire Retardant Plastic

IGNIX resin

Introduction to Innovative
Fire Retardant Plastic



Problem Statement

- ✓ EVs using lithium-ion batteries have the potential for thermal runaway, which increases the risk of fire hazards and leads to fires that are challenging to control.



Cause and Effect to Resolution

Root Cause

- ✓ Occurrence of physical and chemical defects in lithium-ion batteries due to instability caused by both internal and external factors
- ✓ Exposure to fire risk caused by battery overcharging and short-circuiting
- ✓ Insufficient precautions against fire resulting from the limitations of oxidation and thermal stability in battery materials

Cause and Effect to Resolution

Current Lithium-ion Battery Enclosure in EVs

Aluminum Alloy Material Enclosure

- Aluminum alloy materials exhibit a significant reduction in strength when exposed to high temperatures due to their low melting point.
- The ALDC12 model of aluminum alloy is utilized for die casting to achieve high strength; however, it has the drawback of low heat dissipation properties.



Solution

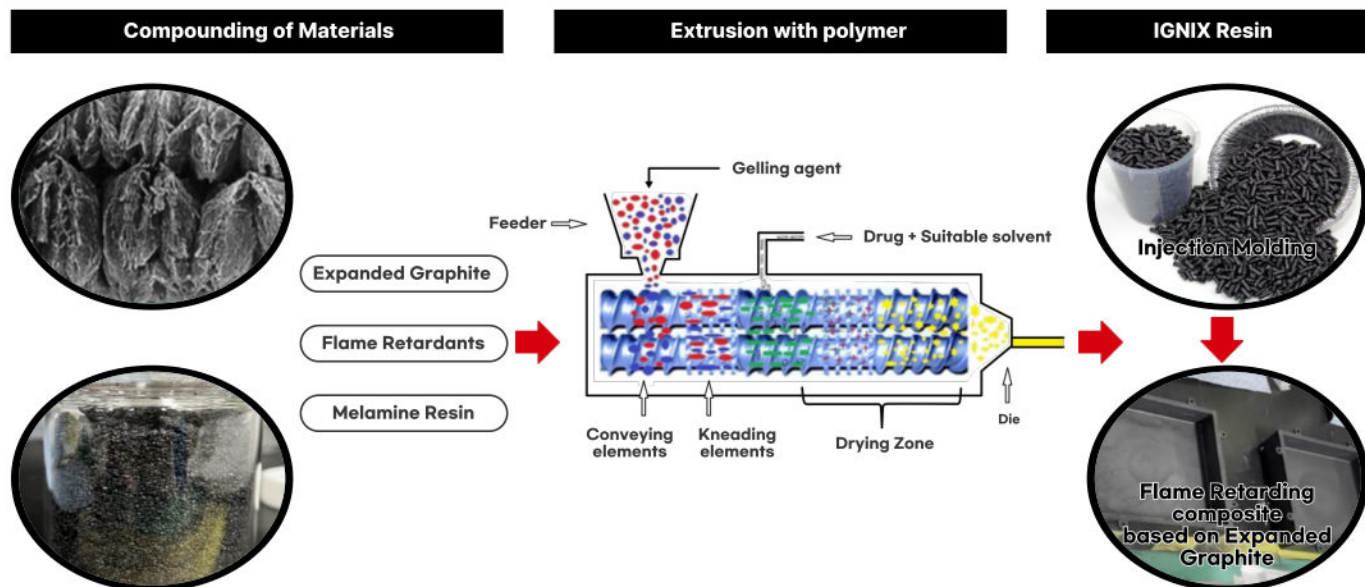
- Development of external battery materials designed for fire suppression in battery components (metals).
- Development of lightweight materials with maximized impact resistance
- Development of application technologies for battery housing employing flame-retardant materials.

Cause and Effect to Resolution

Effect of applying to new invented expanded graphite & polymer composite material for covering Lithium-ion Battery

Classification	Aluminum alloy-based battery Housing	Expanded Graphite & Polymer composite material-based battery housing
Cost	Approx. 500 to 600 USD (Price increase due to the addition of copper, iron, and other metallic substances to aluminum)	Approx. 360 to 450 USD (Expanded graphite material is 50% lighter than aluminum, and the added polymer is approximately 30% lighter than added metals.)
Weight(kg)	100~200 kg	Under 100kg
Processability	Molding temperature → 700°C ~ 1200°C	Molding temperature under 250°C [Facilitated processability]
Fire hazard	In the event of an electric vehicle fire, the reaction between aluminum alloys and water generates hydrogen → Increased explosion risk	Reduction of explosion risk due to flame retardant and extinguishing properties.

Innovative Expanded Graphite Resin: IGNIX

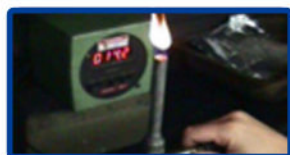


3-step mechanism to prevent thermal runaway

- The primary oxygen barrier and thermal runaway suppression due to the reaction of expanded graphite during combustion.
- Endothermic reaction due to the secondary action of melamine resin and char formation through reaction with phosphorus-based fire retardants (flame retardancy).
- Fire and thermal runaway suppression through the tertiary action of the fire retardant (esterification reaction).

Testing standards

Specifications for expanded graphite material Certification



Flame retardancy

- ☒ International flame retardancy testing standard UL 94 Test



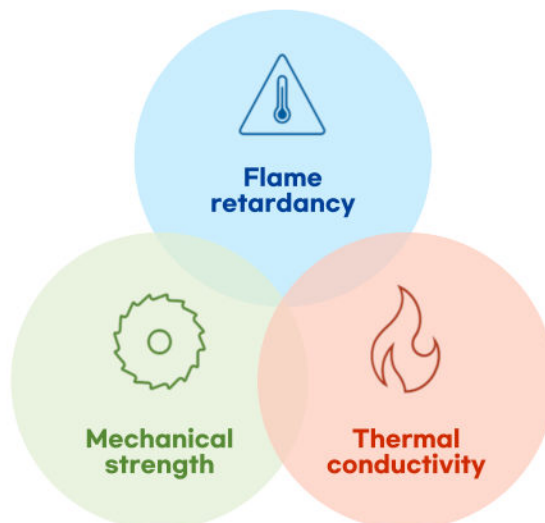
Mechanical strength

- ☒ ASTM D3039 Composite Material Tensile Test
- ☒ Fatigue strength
- ☒ Fatigue properties



Thermal conductivity (thermal exposure test)

- ☒ ASTM E1530 Thermal Conductivity Measurement
- ☒ Regulation No. 48 on the performance and standards of automotive and automotive components.



Test Report

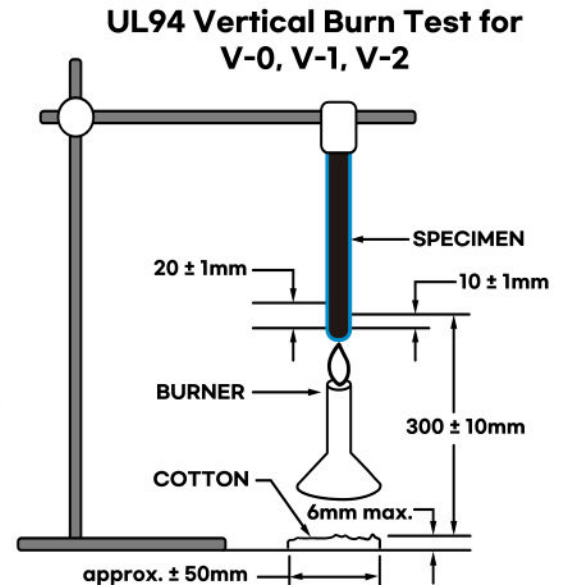
Specifications for expanded graphite material Certification → **UL-94 V Test verification method**

1. When a flame is applied vertically to the sample, evaluate the sample's combustion pattern and the extent of flame propagation to the surroundings.

- ① Sample Bar → shaped sample
- ② Sample specifications → 125 (mm) X 13 (mm) X Thickness (mm)

2. Test method

- ① After applying a 20 mm flame to the sample for 10 seconds, measure the combustion time t1 and record the combustion pattern.
- ② If combustion ceases after the first flame application, reapply the flame for 10 seconds. Measure the sample's combustion time t2 and glowing time (spark retention time) t3 and record the combustion pattern.
- ③ Evaluate the combustion t1, t2 and t3 assess the combustion pattern, including factors such as ignition of cotton by dripping and flame propagation to the clamp. Based on these observations, determine the rating (V-0, V-1, V-2).



BEYOND ASIAN HUB, TOWARD GLOBAL WORLD



TEST REPORT

우 13810 경기도 과천시 교육원로 98(중앙동)

TEL (031)853-8072 FAX (031)853-8075

성적서번호 : TAK-2024-069616

접 수 일 자 : 2024년 05월 08일

대 표 자 : 정현택

시험완료일자 : 2024년 05월 13일

업 체 명 : 주식회사 제이와이테크머트리얼즈

주 소 : 경기도 고양시 덕양구 향동로 218, 씨동 317호(향동동, 현대테라타워디엠씨)

시 료 명 : 팽창흑연 복합소재

시 험 결 과				
시험항목	단위	시료구분	결과치	시험방법
20 mm 수직연소시험 ; V-0, V-1, or V-2	-	-	V-0	UL 94 : 2013(*)

(*) 전처리 : (23 ± 2) °C, (50 ± 5) % R.H., 48 시간, 시험편 두께 5 mm

- 용 도 : 품질관리용

비 고 : 1. 이 성적서는 의뢰자가 제시한 시료 및 시료명으로 시험한 결과로써 전체 제품에 대한 품질을 보증하지 않으며, 성적서의 진위확인인 홈페이지(www.ktr.or.kr) 또는 QR code로 확인 가능합니다.
 2. 이 성적서는 홍보, 선전, 광고 및 소송용 등으로 사용될 수 없으며, 용도 이외의 사용을 금합니다.
 3. 이 성적서는 원본(재발행 포함)만 유효하며, 사본 및 전자 인쇄본/파일본은 결과치 참고용입니다.

위 성적서는 KS Q ISO/IEC 17025 및 KOLAS 인정과 관련이 없음을 밝힙니다.

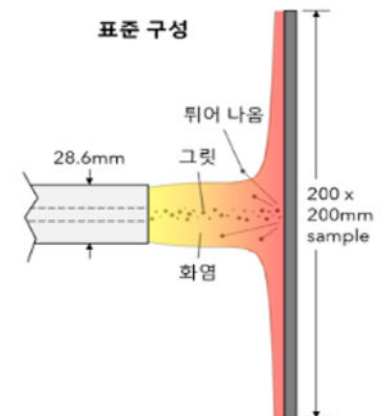
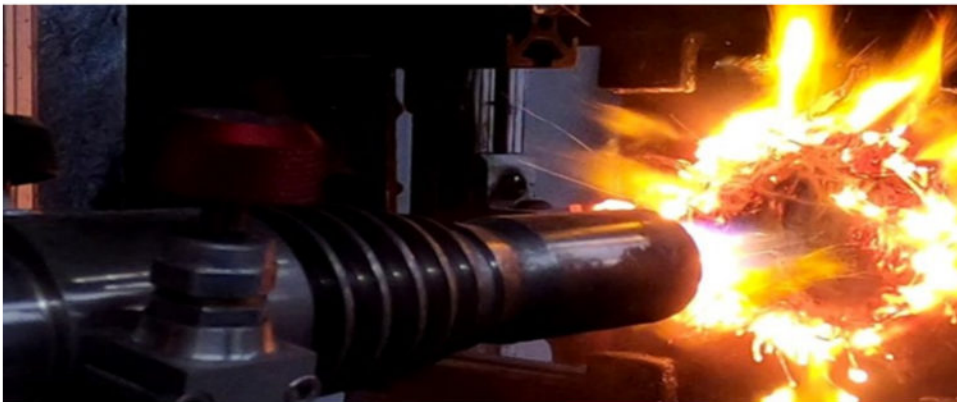
Application of IGNIX for enclosing lithium-ion battery

Objectives

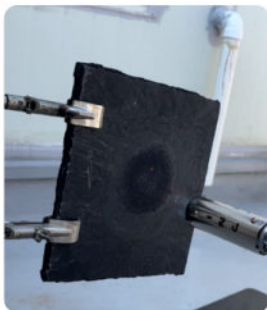
- The prevention of thermal runaway propagation and fire suppression in lithium-ion battery packs in electric vehicles by using the battery housing based on the **IGNIX**.
- Minimizing human and material damage through the prevention of thermal runaway propagation and fire suppression.
- The **IGNIX** based on expanded graphite is anticipated to improve flame resistance and provided effective extinguishing capabilities, facilitating initial suppression and prevention of fires upon occurrence.
- Contribute to the extension of the electric vehicle market by **IGNIX** technologies that enhance safety and thermal runaway management through the prevention of battery fires and propagation.

Torch Test

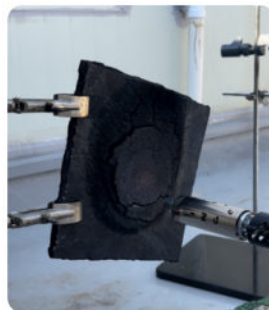
Specifications for expanded graphite material Certification → UL 2596
verification method - not introduced domestically



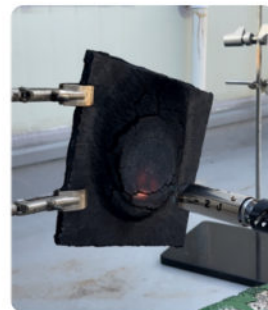
Development material torch test conducted using a homemade torch test.
(240 mm x 240 mm x 10 mm)



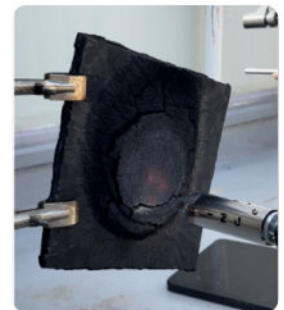
Start the test



After 10 min



After 20 min



After 30 min



The sample based on the H-Tex Shield resin showed no significant physical defects, even when heated with over the 1300 °C gas torch.

Battery Enclosure Fire Safety Test

Secondary battery fire safety test

ESS (Energy Storage System) fire safety test

- Fire safety testing and characterization analysis of secondary battery cells, modules, packs, and racks (units) for ESS (Energy Storage System) applications.
- Applicable products Battery cells, modules, packs, and racks (units).

Pre-testing and extinguishing tests for other secondary battery systems

- Analysis of thermal runaway characteristics and extinguishing performance testing for battery and battery system-related products.
- Applicable products Battery cells, modules, packs, and racks (units).



KTC
Korea Testing Certification

시험 결과

성적서 번호 : GT2024-11416

1. 열폭주 전이 시험

A. 세부 시험 결과

A-1 시험 방법

시료를 아래 방법에 따라서 시험한다.

1. 충전된 배터리 2개 사이에 열원을 부착한다.
2. 열원을 부착한 배터리를 시료에 넣고 밀봉한다.
3. 시료 외부의 양옆에 배터리를 밀착시켜 놓는다.
4. 시료 내 배터리가 열폭주 발생할 때까지 열원의 온도를 올린다.
5. 열폭주 발생 후 시료의 상태를 관찰한다.

※ 배터리 충전 상태는 의뢰자 제시임.

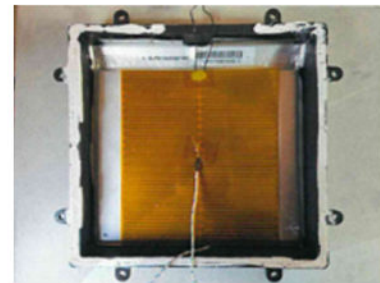
A-2 시험 결과

시료	시험 결과
시료 1	배터리 열폭주 후 화염 분출 및 시료 주변 배터리에 전이 없음.

A-3 시료 사진 및 세부 데이터

시료	시험 전 전압 (V)	시험 후 전압 (V)	최대 온도
외부 배터리1	4.24	4.22	149.4
외부 배터리2	4.15	4.14	119.7

시료 1 세팅

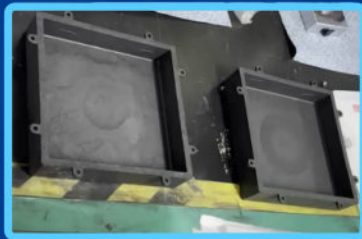


시료 1 시험 세팅



Related Application

◆ Available Application: Lithium-Ion Battery Enclosure made by IGNIX resin



◆ Future Applications by IGNIX resin

- 1 Energy Storage (ESS)**
Thermal insulation in EV battery packs and ESS
- 2 Hydrogen & Fuel Cells**
Thermal management in hydrogen storage and fuel cells
- 3 Electronics & Semiconductors**
Battery protection in smartphones, laptops, and power semiconductors
- 4 Aerospace & Defense**
Thermal protection for spacecraft, satellites, and military equipment
- 5 Electric Vehicles (EVs) & Mobility**
Flame-retardant and thermal barrier materials in EVs and drones
- 6 Chemical & Industrial Processes**
Temperature control in hazardous material storage and reactors
- 7 Construction & Fire Safety**
Fire-resistant materials in buildings and industrial sites



Contact

Division of Energy Engineering, Daejin University, Republic of Korea
Associate Prof. Hyeon Taek Jeong (Ph.D.)
Email : jht4321@daejin.ac.kr