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# DAMAGE SELF-SENSING BEHAVIOR OF BASALT FIBER REINFORCED POLYMER COMPOSITES MODIFIED BY ELECTROPHORETIC DEPOSITION

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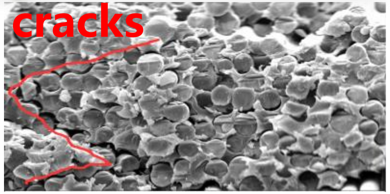
# Outline

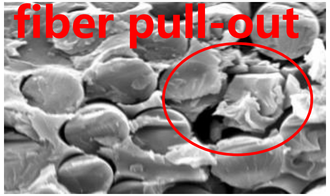
# 1 Background

**Basalt fiber (BF)** is a green and environmentally friendly high-performance fiber, with a much lower cost than aramid and carbon fibers.



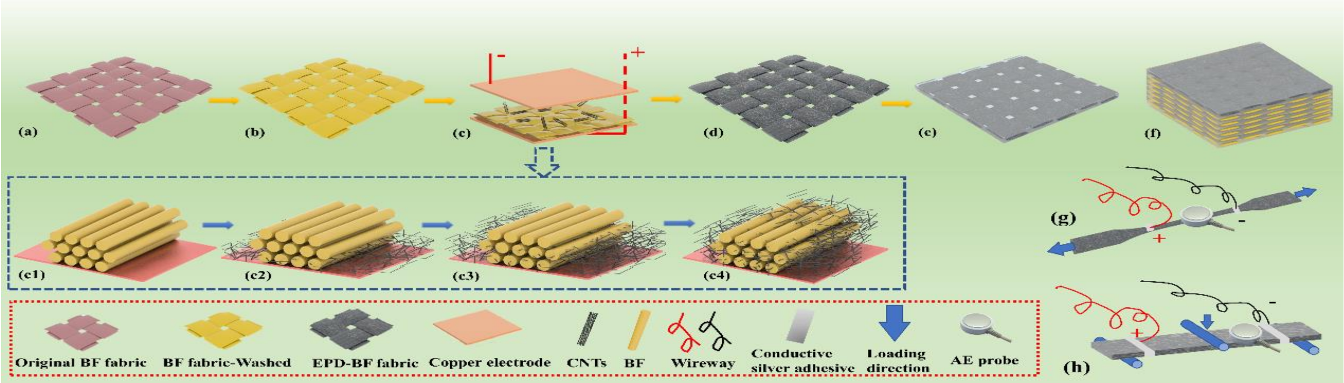




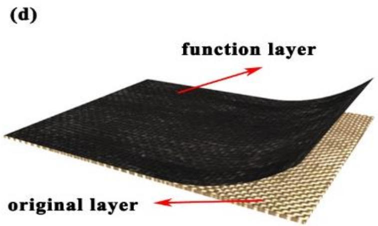


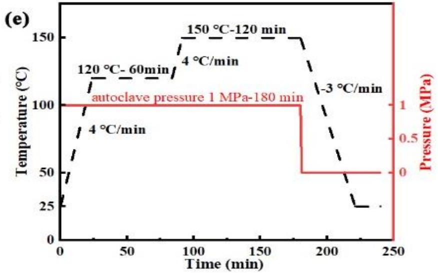

The high chemical inertia and smooth surface of BF lead to its low bonding ability with the resin, and complex damage is difficult to detect. External detection equipment has many limitations.

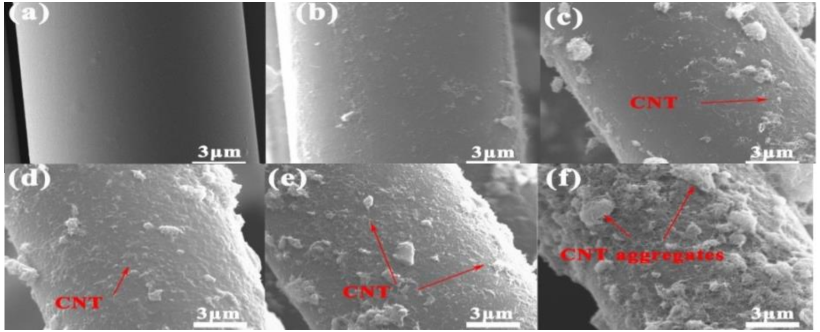
# 2 Method




**Orientated deposition of carboxylated CNTs on BF under an electrical field by EPD**



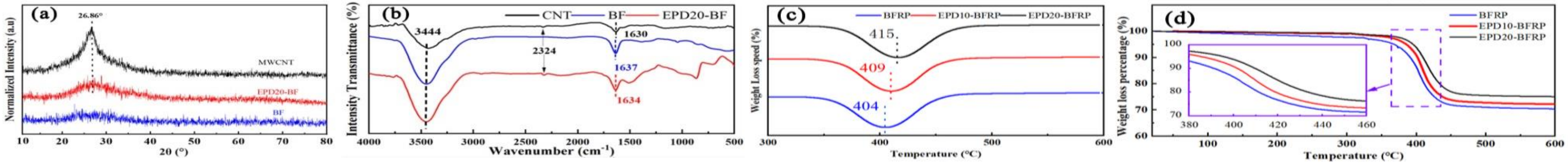



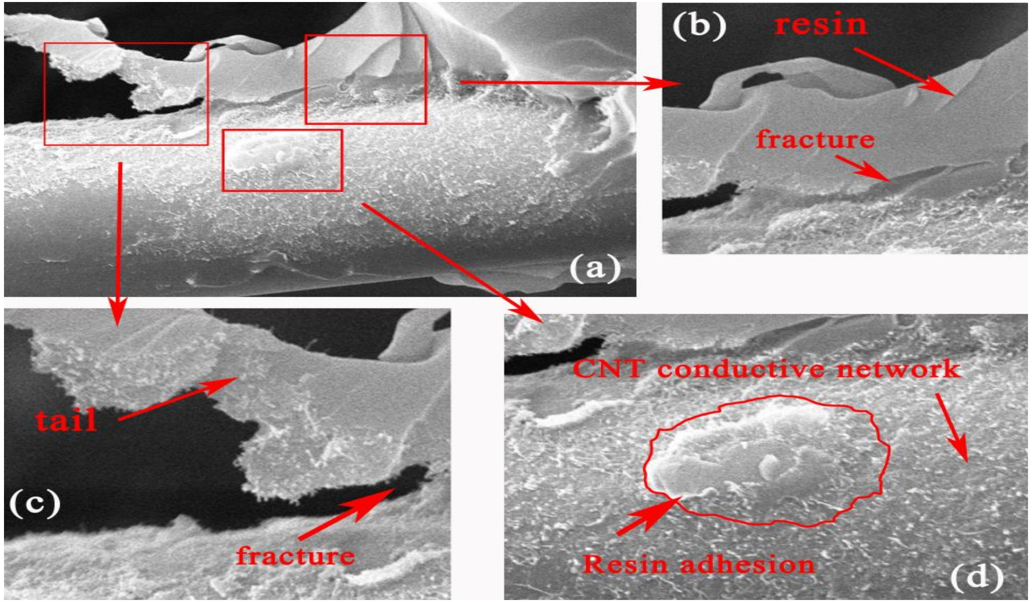



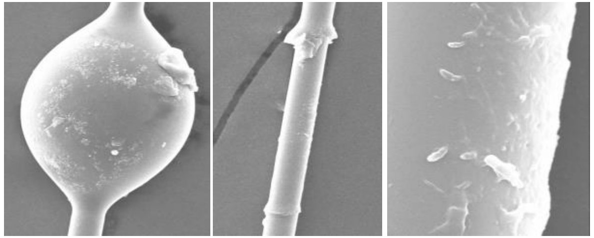

**The interface bonding is improved while making it functional with uniformly deposited CNTs .**

# 3 Results

## Structural characterization and interfacial performance of BFRP



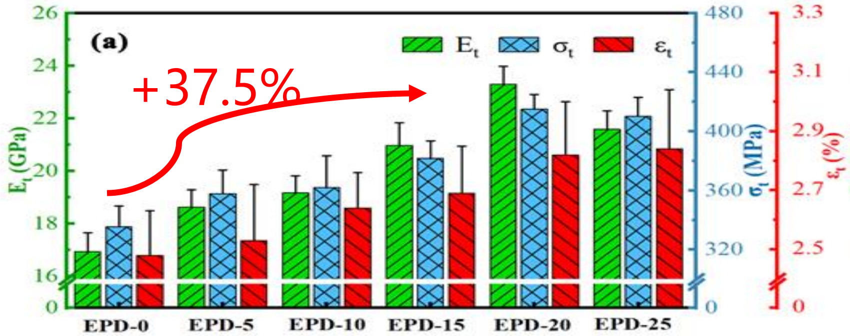



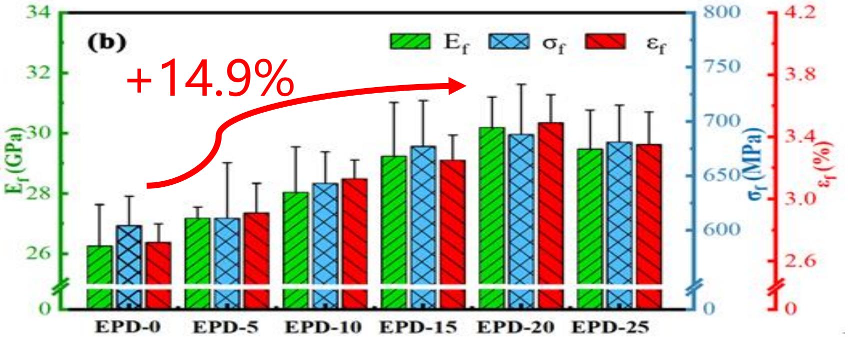
**CNTs in the modified interface causes cracks to deflect, preventing crack extension.**

# 3 Results

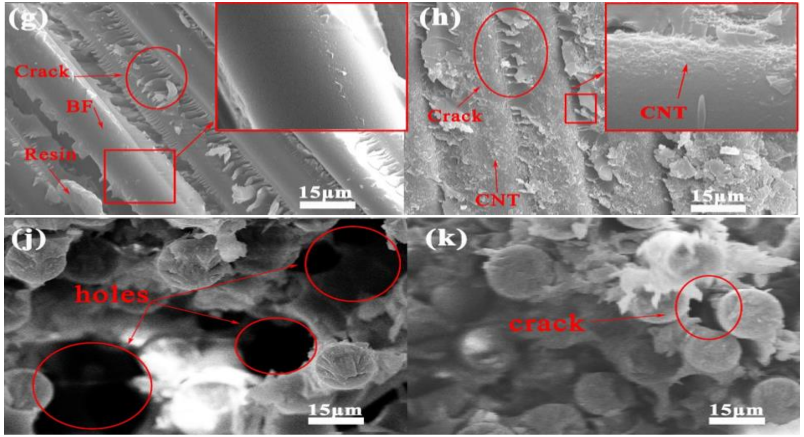
## Mechanical and electrical properties of BFRP modified by EPD




tensile




flexural



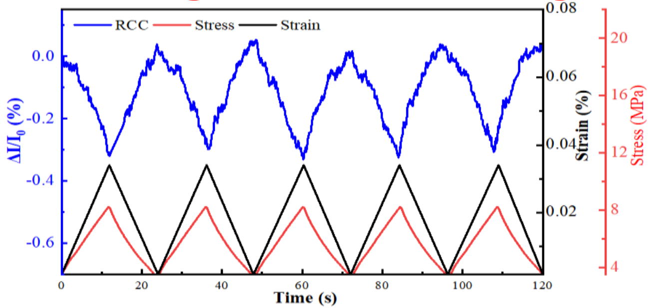

| Sample | Resistivity (kΩ·mm$^{-1}$) | |
|---|---|---|
| | Cross-layer | Through-layer |
| BFRP | N/A | N/A |
| EPD5-BFRP | 44.2(±2.4) | 895.3(±9.4) |
| EPD10-BFRP | 39.1(±3.1) | 600.4(±7.0) |
| EPD15-BFRP | 36.8(±2.1) | 313.78(±3.8) |
| EPD20-BFRP | 34.8(±1.6) | 233.4(±7.1) |
| EPD25-BFRP | 35.1(±3.3) | 247.6(±1.3) |

**Optimal deposition voltage is 20 V**

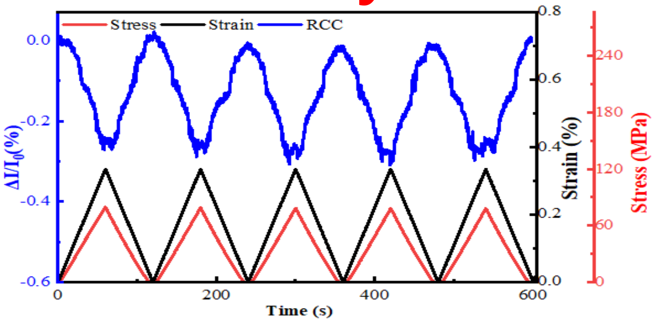
# 3 Results

## Damage self-sensing of BFRP modified by EPD

**Elastic strain**

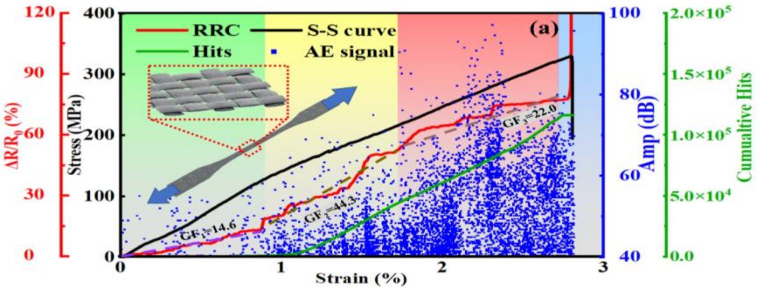



Tensile

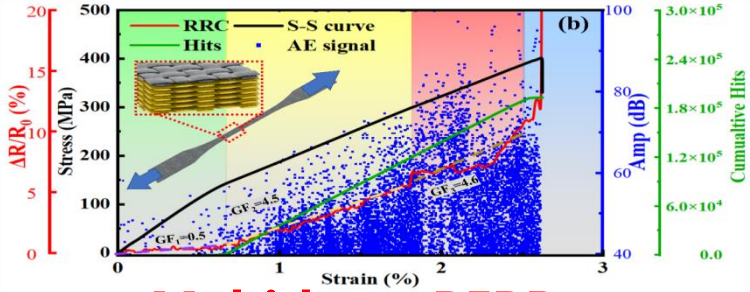



Flexual

**Tensile to break**




Single-layer BFRP




Multi-layer BFRP

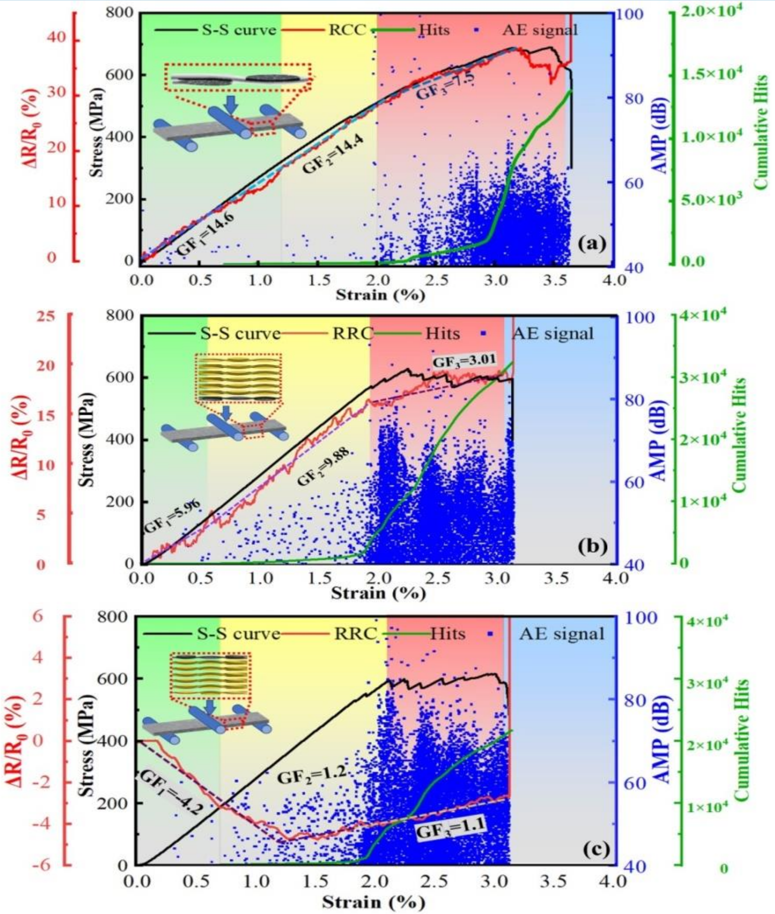
**Functionalized single-layer and multi-layer BFRP exhibited similar electrical signal responses to tensile load. The acoustic emission (AE) signals agreed well with RRC.**

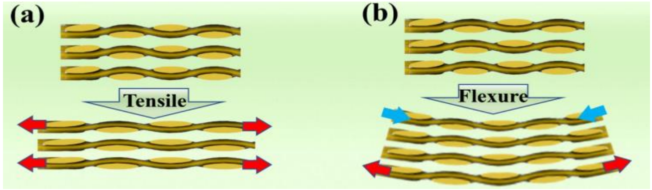
# 3 Results

Single-layer

Multi-layer (lower EPD)

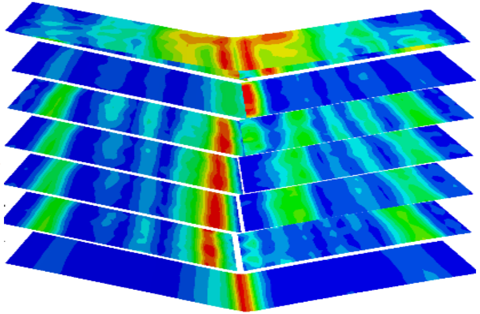
Multi-layer (upper EPD)




The multi-layer BFRP containing a single-layer EPD20-BFRP on the upper or lower surface of laminate exhibited distinct RRC under flexural loading.

Position



# 4 Conclusions

- The tensile and flexural moduli of modified EPD-BFRP increased by 37.5% and 14.9% respectively.
- Single-layer EPD20-BFRP exhibited a high gauge factor (GF) of 44.3 during tensile damage self-sensing.
- The AE signals during tensile and flexual damage process agreed well with the RRC, which confirmed different damage stages within loading process, such as elastic deformation, damage evolution, crack coalescence, and complete fracture.
- The multi-layer BFRP containing a single-layer EPD20-BFRP on the upper or lower surface of laminate exhibited distinct electrical signal responses under flexural loading, due to different strain states.

# Acknowledgement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**Thank You for your attention!**


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