

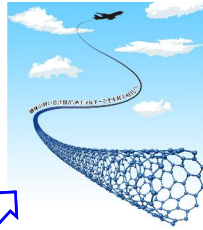
# High-Strength Aluminum Matrix Composites Reinforced with in-Situ $Al_4C_3$ Nano-Rods

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## Research Purpose & Motivation

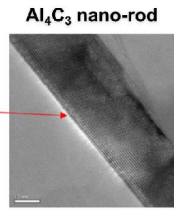
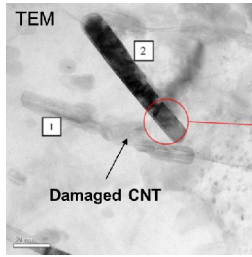
Carbon nanotubes (CNTs)

- **Light weight** (1.2-2.1 g/cc)
- **High strength** (~100 GPa)
- High Young's modulus (~1 TPa)
- Large aspect ratio (100-1000)



➔ **Light & strong CNT/Al**

CNT damage and in-situ carbide



Transform damaged CNT to  $Al_4C_3$

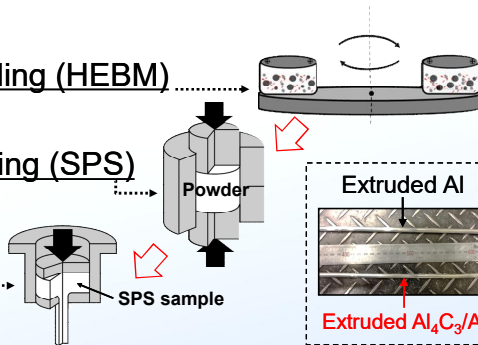
**Light & strong  $Al_4C_3/Al$**

## Preparation process of in-situ $Al_4C_3/Al$ composites

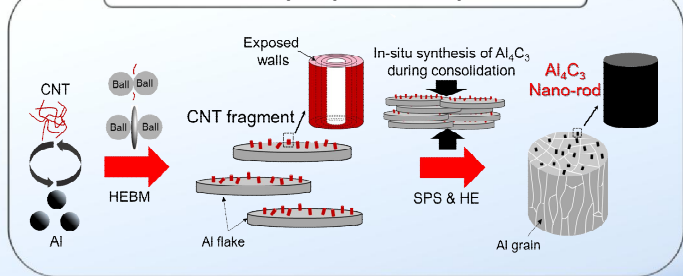
1. High energy ball milling (HEBM)

2. Spark plasma sintering (SPS)

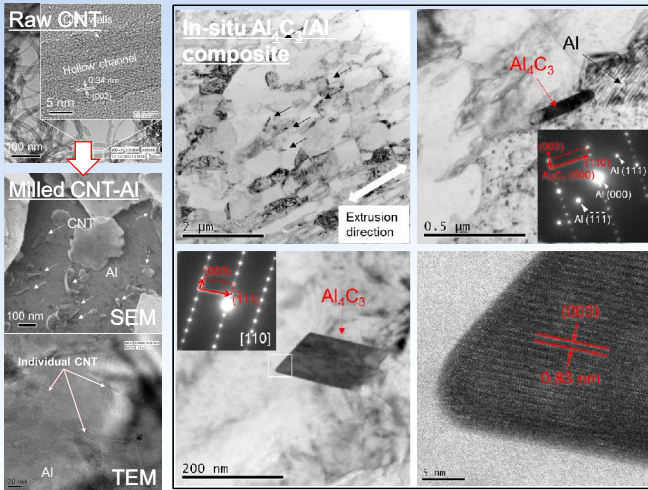
3. Hot extrusion (HE)



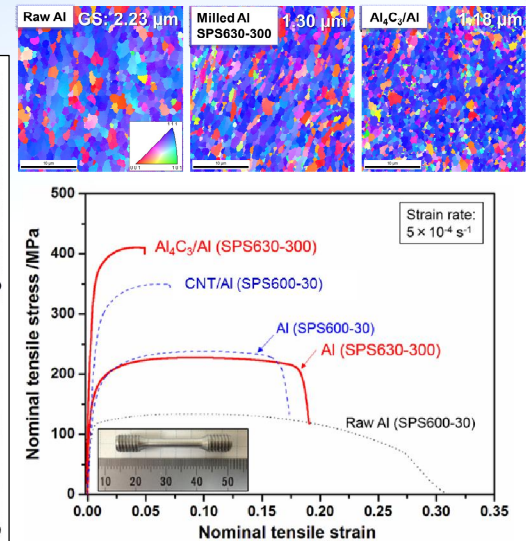
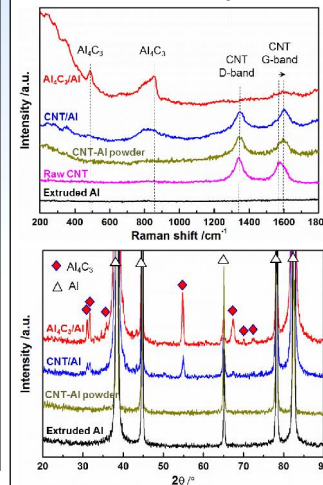
Scheme of preparation process



## Microstructures and mechanical properties of $Al_4C_3/Al$



Raman and XRD profiles



## Conclusions

- **Novel in-situ reinforcement** of  $Al_4C_3$  nano-rod was synthesized in Al matrix composites using a **powder metallurgy** route.
- **Shortened CNTs** were completely transformed to  $Al_4C_3$  nano-rods by **template reaction** of CNT with Al matrix via an in-situ PM.
- In-situ  $Al_4C_3/Al$  showed greatly enhanced mechanical properties, such as 90% increased **yield strength (307 MPa)** and 78% increased **tensile strength (403 MPa)**, compared with the ball milled Al material.

