Docket #: S20-009

An Ultralight, Fire-Retardant Current Collector for Safe, High Energy Density Batteries

Researchers in Stanford's Yi Cui Lab have developed an ultra-light, fire-retardant battery current collector. Commercial Cu-Al current collectors account for 15-50 wt.% of the total battery weight – dead weight that dramatically limits battery density. Thus far, strategies for safer and higher energy density batteries have fallen short. The Yi Cui Lab design uses a fire retardant, triphenyl phosphate (TPP) embedded, lightweight polyimide (PI) that is coated on both surfaces with an ultrathin layer of copper (Figure 1). The copper distributes current and protects the fire-retardant polymer. Full cells with the **PI-TPP-Cu** current collector shows significantly increased energy density by 16~26% compared to commercial Cu and Al foil current collectors, and is cheap and easy to manufacture. This universal current collector design holds enormous promise for safer lithium batteries with higher energy density for different battery systems.

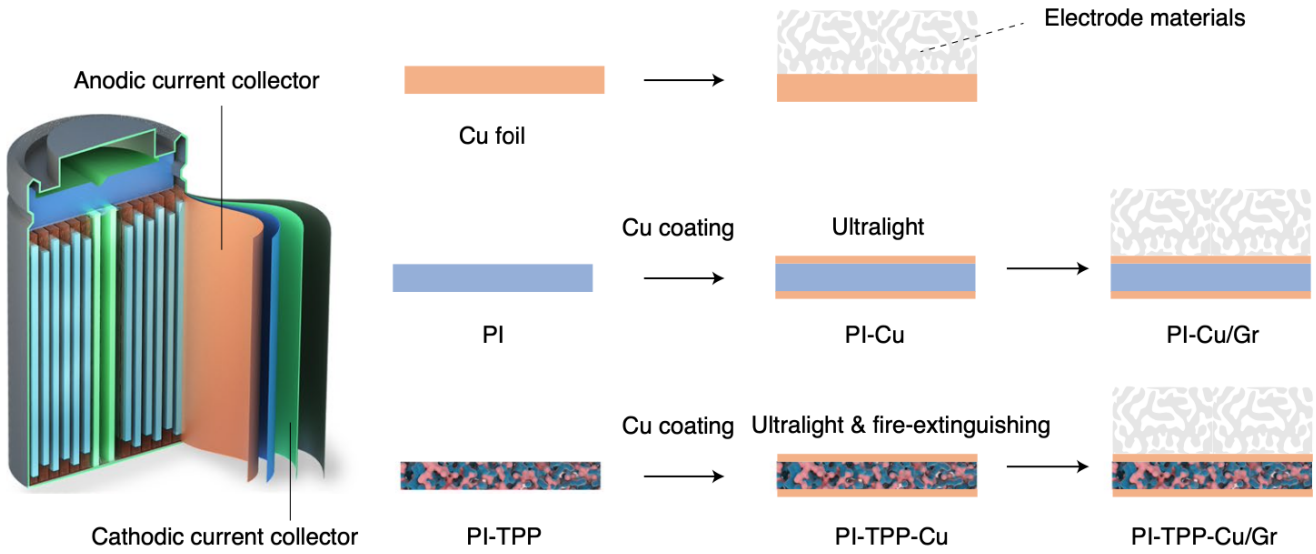


Figure 1 Current collector designs. Top) Heavy and bulky pure Cu current collectors. Middle) Lighter Polyimide-Copper current collector. Bottom) **Stanford's Yi Cui Lab developed PI-TPP-Cu Current Collector**. Ultralight, flame retardant current collector design with ultrathin metal layers on both sides of a triphenyl phosphate (TPP) flame retardant embedded polyimide layer. Schematic courtesy the Yi Cui Lab.

Stage of Development – Prototype
The Yi Cui Lab ultralight, fire-retardant design prototype demonstrated fire extinguishing properties and maintained normal battery performance.

Applications

- Universal **current collector** for a variety of **battery** systems (e.g. lithium batteries, sodium batteries, potassium ion batteries, aluminum ion batteries, etc.)

Advantages

- 80% Lighter with roughly 20% increase in energy density (compared to average 3% increase in recent years).
- Safer - Fire retardant and self-extinguishing.
- Cheap.
- Easy to commercially manufacture.

Publications

- Ye, Yusheng, Lien-Yang Chou, Yayuan Liu, Hansen Wang, Hiang Kwee Lee, Wenxiao Huang, Jiayu Wan et al. "Ultralight and fire-extinguishing current collectors for high-energy and high-safety lithium-ion batteries." *Nature Energy* 5, no. 10 (2020): 786-793. https://doi.org/10.1038/s41560-020-00702-8

Patents

- Published Application: WO2021211701

- Published Application: 20230163368
- Issued: 12,620,632 (USA)

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