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An ultralight-weight polymer electrolyte fuel cell based on woven carbon fiber-resin reinforced bipolar plate

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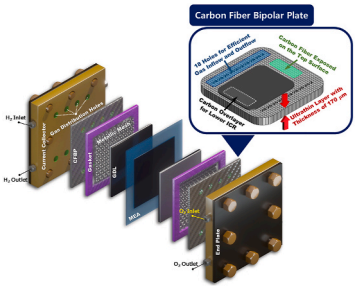
HIGHLIGHTS

- Woven carbon fiber-resin reinforced plate is used for PEFC bipolar plate.
- Exclusive cell structure with carbon fiber bipolar plate is successfully created.
- New bipolar plate shows 6.9x reduced weight when compared with previous graphite one.
- Cell performance is notably improved after introducing conductive carbon layer.

GRAPHICAL ABSTRACT



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ABSTRACT

Exploration towards the lightweight bipolar plate, composed of cheap and abundant materials, is of great importance to accelerate the commercialization of polymer electrolyte fuel cells (PEFCs). Herein, new bipolar plate is fabricated by carbon fiber plate reinforced with polymeric resin, to alternate the conventional graphite composite (GBP) and metallic ones (MBP). Unlike the previous studies, the woven-type carbon fiber bipolar plates (CFBPs), with an initial thickness of 300 μm, have physically been grinded to 270, 220 and 170 μm, then followed by the deposition of conductive carbon layer, in order to reduce both bulk and interfacial contact resistances. Remarkably, the resultant CFBP even with metallic mesh flow fields exhibited less than 14.6% and 23.6% weight of the GBP and MBP, respectively, which doubles the gravimetric cell power density. Three key properties, i.e., electrical conductivity, mechanical strength and gas permeability, fully satisfied the US DOE's 2020 targets. Furthermore, the PEFC employing the proposed CFBP with metallic mesh flow field showed notable improvements in the ohmic and mass-transport performance, confirmed by both cell polarization and electrochemical impedance spectroscopy. Given the excellent gravimetric power density, this work may draw the first step toward a newly-structured PEFC for an automotive, marinomotive and, particularly, aeromotive powertrain applications.

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