

PEM FUEL CELL BIPOLAR PLATE MATERIAL

METAL VERSUS GRAPHITE

FUEL CELL ELECTRIC VEHICLES On the Path to Commercialization

Today, the world's leading automotive manufacturers are advancing the development of fuel cell vehicles. With no emissions at the tailpipe, fuel cell vehicles will play an important role in meeting the air quality improvement goals set by communities.

Fuel cell technology has moved beyond the prototype stage, and fuel cell vehicles are now being put into consumers' hands for real-world operation. Automakers have an eye towards the future, designing fuel cell engines suitable for mass-production volumes.



FUEL CELL BIPOLAR PLATES

One such important design consideration is the bipolar plate material selected for the proton exchange membrane (PEM) fuel cell. The bipolar plate is a key component, connecting each cell electrically, supplying reactant gases and removing reaction by-products from the cell.

Bipolar plates can be made from various materials, with the most common being graphite or metal. Each type of material has its strengths and weaknesses. Tradeoffs must be evaluated with the goal of balancing both material performance and cost-effective manufacturing processes.



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TECHNICAL NOTE

Considerations in Bipolar Plate Material Selection

When assessing a technology for mass production, manufacturers must take into account a variety of technical and strategic material attributes.

Technical

- **Corrosion:** electro-chemical stability to meet lifetime requirements
- **Durability:** strength and ability to meet shock and vibrate requirements
- **Freeze-start:** capability to manage liquid water and minimize effective thermal mass within manufacturing limitations
- **Heat rejection:** strength to operate at $>100^{\circ}\text{C}$
- **Power density:** minimize thickness and maximize area utilization
- **Weight:** minimize stack weight (including fluids)

Strategic

- **Cost:** raw material cost, bipolar plate cost at mass production volumes
- **Recyclability:** strategy to meet recyclability requirements as defined by government directives
- **Supply Chain:** development of raw material suppliers and bipolar plate suppliers
- **Competitors:** competitive landscape, assessment of technology used by competitors

Ballard's Perspective

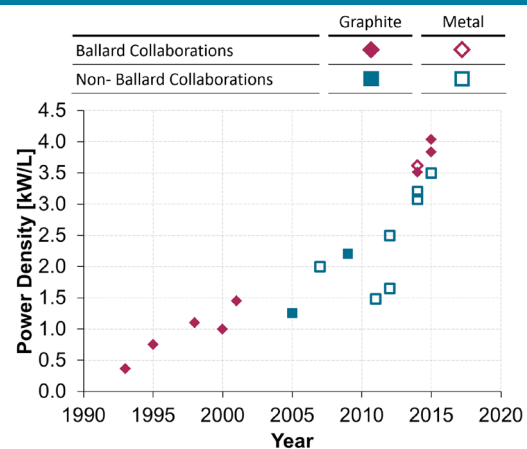
At Ballard, our engineers are leveraging years of experience and extensive collaborations with Tier 1 automotive manufacturers to support critical areas of fuel cell design. Considerable work in the design, manufacture, and test of both metal and graphite bipolar plates have yielded the following assessment.

Historically, the higher mechanical strength of metal compared to graphite enabled a thinner bipolar plate design and subsequently a higher power density. However, mitigating corrosion behavior of conventional metal bipolar plates leads to an increase in product cost.

Recent improvements on graphitic bipolar plate designs and material mechanical strength have reduced the gap between metal and graphite bipolar power density.

Ballard designs metal and graphite fuel cell stacks that exceed intermediary automotive technical targets on the path to commercialization. Our industry-leading technical achievements include stack power $>100\text{ kW}$, power density $>3.5\text{ kW/L}$ and plate assembly thickness $<1\text{ mm}$.

Power Density



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