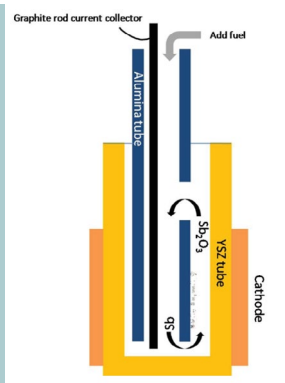

Direct Carbon Fuel Cell Stack Designs

PENN CENTER FOR INNOVATION
Empowering Ideas

Inventor
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STAGE OF DEVELOPMENT
Prototype system demonstrated in laboratory

INTELLECTUAL PROPERTY
Patent application filed

REFERENCE MEDIA
Gorte et al. (2013). AIChE Journal

Gorte et al. (2011). Energy & Environmental Science.

DESIRED PARTNERSHIPS
- License
- Co-development

LEARN MORE
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Problem
The world has an ever-growing need to provide energy while limiting harm to the environment. Carbon based fuels are cheap and abundant, but generating electricity by burning these fuels creates harmful byproducts. Alternative energy sources such as traditional fuel cells face economic challenges due to the difficulty and expense of preparing and transporting hydrogen.

Solution
Direct carbon fuel cells operate on a variety of solid carbon-based fuels which could include coal, wood, or biomass. This technology allows for electricity to be generated from sources traditionally considered "dirty" with far less impact to the environment than burning them. Additionally, in this process the fuels are consumed in their solid form directly without the need for gasification, enhancing the overall efficiency of the process. Fuel cells constructed in this way are highly efficient and produce negligible Nitric Oxide emissions as compared to combustion processes. The Carbon Dioxide byproduct of fuel cell oxidation is highly concentrated and can easily be captured and sequestered.

Most previous direct carbon fuel cells require special forms of carbon or use only a fraction of the carbon to generate electricity. Researchers at the University of Pennsylvania have demonstrated that molten-metal electrodes are able to generate electricity efficiently for essentially any form of carbon and to use all of that carbon for electricity generation. They have also developed a tubular fuel cell design that circulates a liquid metal anode through the fuel cell. The natural-convection-driven motion requires no mechanical parts and allows for easy removal of non-combustible ash that might be in the fuel. By overcoming some of the challenges of direct carbon fuel cells, this design offers a promising method of efficient electricity generation from carbon fuels.

Advantages
- Electricity generation from abundant and cheap carbon fuels
- Lower carbon emissions than combustion processes
- Convection based recirculation of molten metal anode improves cell efficiency and reliability