# Coal Conversion in a Fluidized Bed Direct Carbon Fuel Cell


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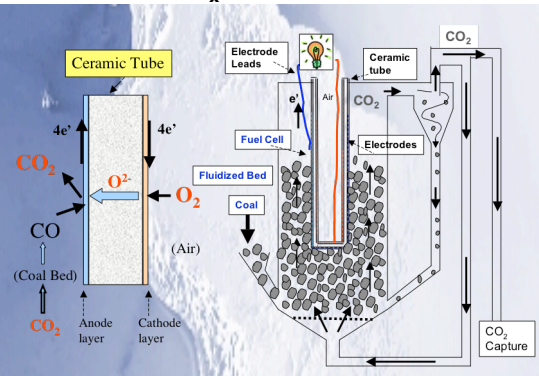
***Direct Carbon Technologies*** **(DCT) is developing its proprietary fluidized bed direct carbon fuel cell (FB-DCFC) technology to commercialization.**

**DCT has already demonstrated efficient conversion of coal, carbon and biomass into electricity in its proprietary FB-DCFC [1-4].**

*"Direct" implies to conversion in a single process chamber.*

## *FB-DCFC's Advantages*

- **Flexibility to employ a wide range of solid fuels**
- **Consumes no water**
- **No nitrogen enters process stream**
- **Produces capture-ready $CO_2$**
- **High conversion efficiency**
- **Less coal or biomass per unit of electricity generated**
- **Produces less $CO_2$ per unit of electricity generated**
- **No or minimal $NO_x$ emissions**




## Operating Principle of FB-DCFC
**(Current Understanding)**

**Boudouard reaction in coal bed**

$$C_{(s)} + CO_{2(g)} = 2CO_{(g)}$$

**On SOFC anode**

$$2CO_{(g)} + 2O_o^{x}{}_{(YSZ)} = 2CO_{2(g)} + 2V_o^{\cdot\cdot}{}_{(YSZ)} + 4e'_{(electrode)}$$

**Net Bed-side**

$$C + 2O_o^{x}{}_{(YSZ)} = CO_{2(g)} + 2V_o^{\cdot\cdot}{}_{(YSZ)} + 4e'_{(electrode)}$$

**On SOFC Cathode**

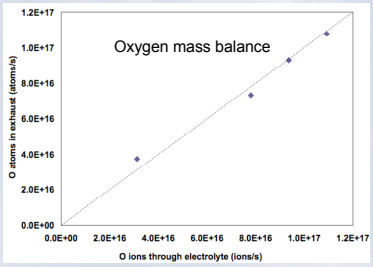
$$O_{2(g)} + 2V_o^{\cdot\cdot}{}_{(YSZ)} + 4e'_{(electrode)} = 2O_o^{x}{}_{(YSZ)}$$

**OVERALL Cell Reaction**

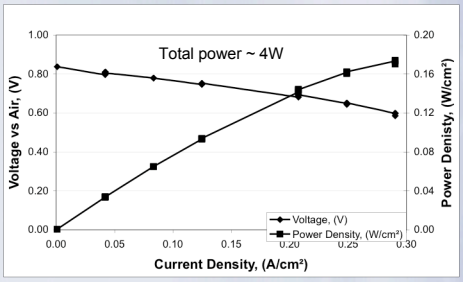
$$C_{(s)} + O_{2(g)} = CO_{2(g)}$$

## Solid fuels converted in FB-DCFC

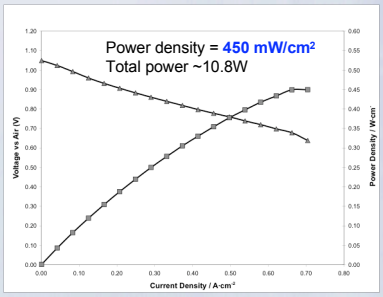
| | |
|---|---|
| Coal | Lower Kittanning, PA |
| Coal | Pittsburgh #8, PA |
| Coal | Waterfall Seam, Kenai-Cook Inlet County, AK |
| Synthetic carbon | Osaka Gas |
| Activated carbon | Fisher |
| Activated carbon | (biomass derived) |
| Biomass | Almond shells |



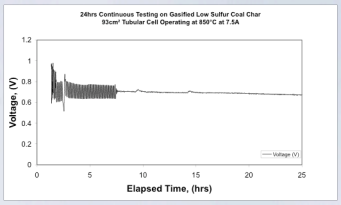

**FB-DCFC on Activated Carbon at 850 °C**

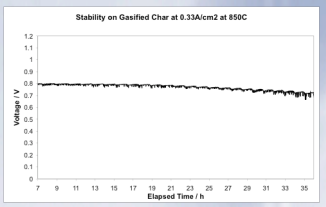



**FB-DCFC on Alaska Coal Char at 850 °C**




**FB-DCFC Stability Testing at 850 °C on Gasified Coal**





**References:**
1. A. C. Lee, S. Li, R. E. Mitchell, T. M. Gür, *Electrochem. Solid-State Lett.* ***11(2)****, B20 (2008)*
2. S. Li, A. C. Lee, R. E. Mitchell, T. M. Gür, *Solid State Ionics* ***179****, 1549 (2008)*
3. A. C. Lee, R. E. Mitchell, T. M. Gür, *AIChE Journal* ***55****(4), 983 (2009)*
4. A. C. Lee, R. E. Mitchell, T. M. Gür, *J. Power Sources* (in print)



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