Solid Oxide Fuel Cells Unmanned Air Vehicles

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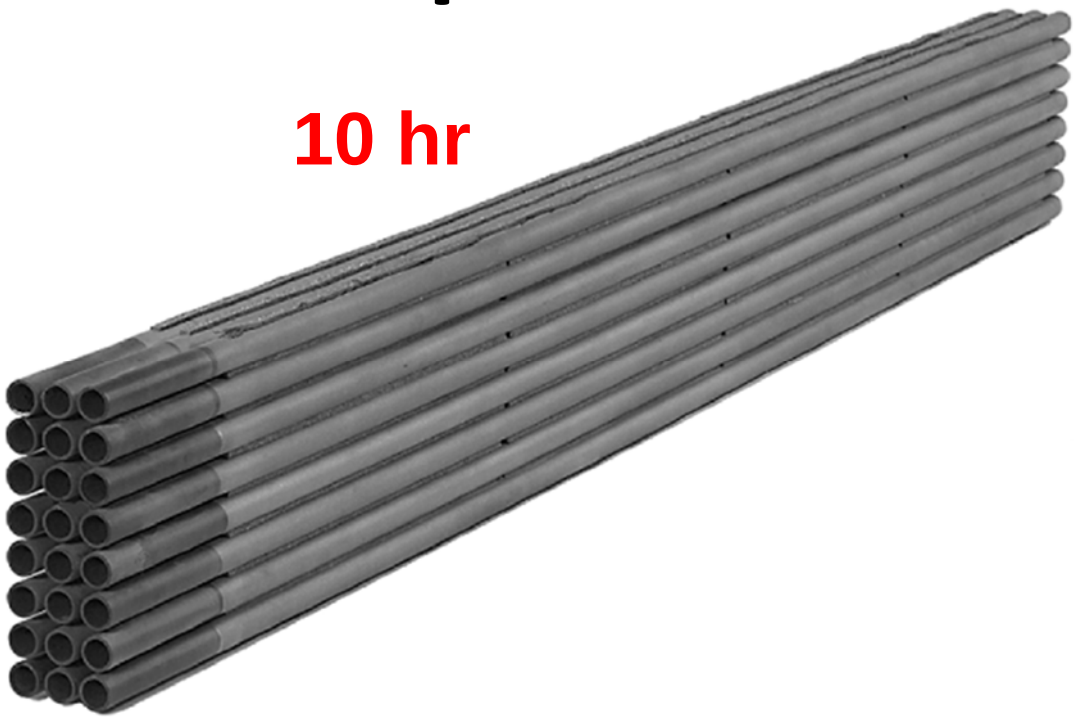
CAN SOFCs WORK?

- Too long to warm up

10 hr

- Too heavy



10 W/kg

TWO PROBLEMS of UAVs

Range of electric UAVs

Regulations

TWO PROBLEMS of UAVs

Range of electric UAVs

30 minutes

Regulations

2015 significant changes

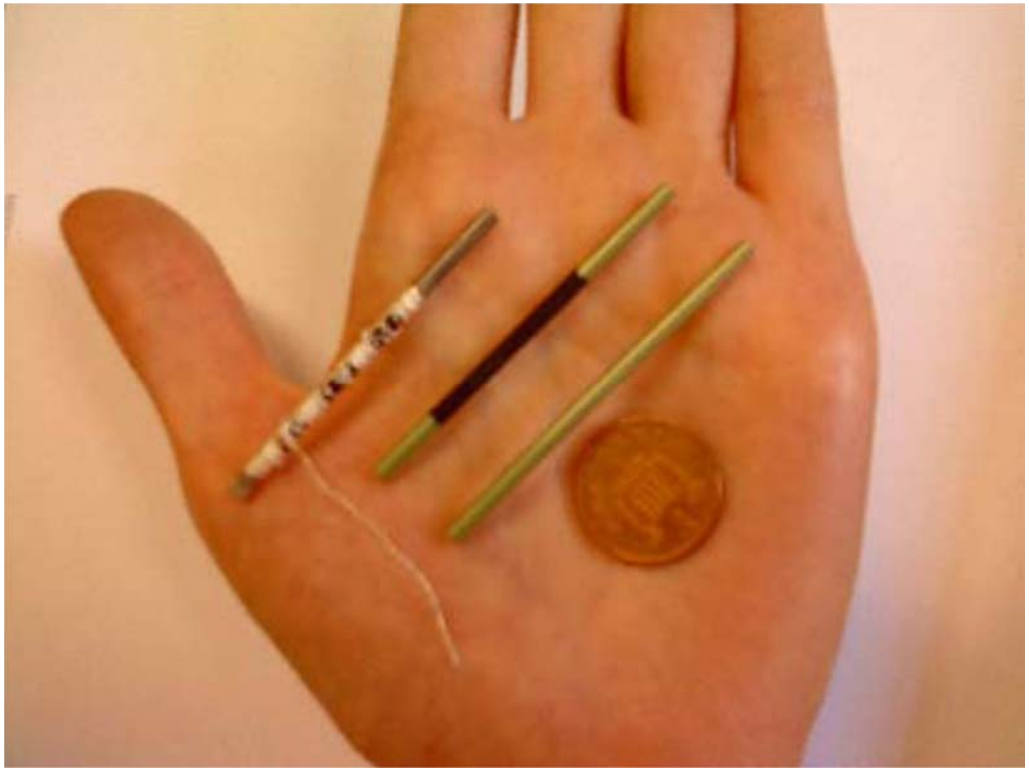
Two Contributions

- **Invention**

  10 sec warm-up, 100W/kg

- **Company**

ADELAN



Microtubular SOFCs

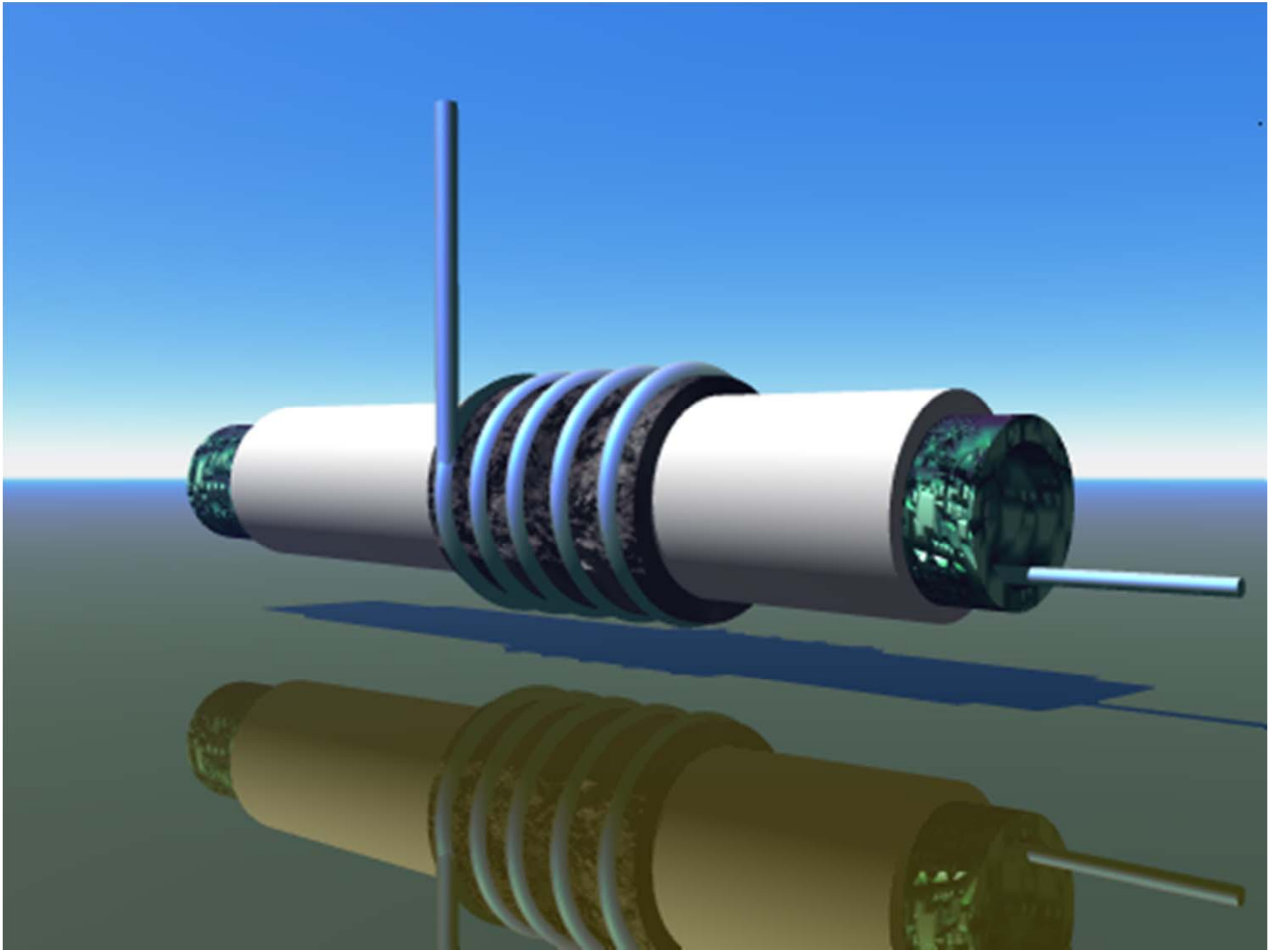
mSOFCs

Invented by KK & MK 1992

faster heat-up time is main feature of this technology

smaller diameter gives a higher power density, 100W/kg

but it is more difficult to make the connections for larger numbers of cells



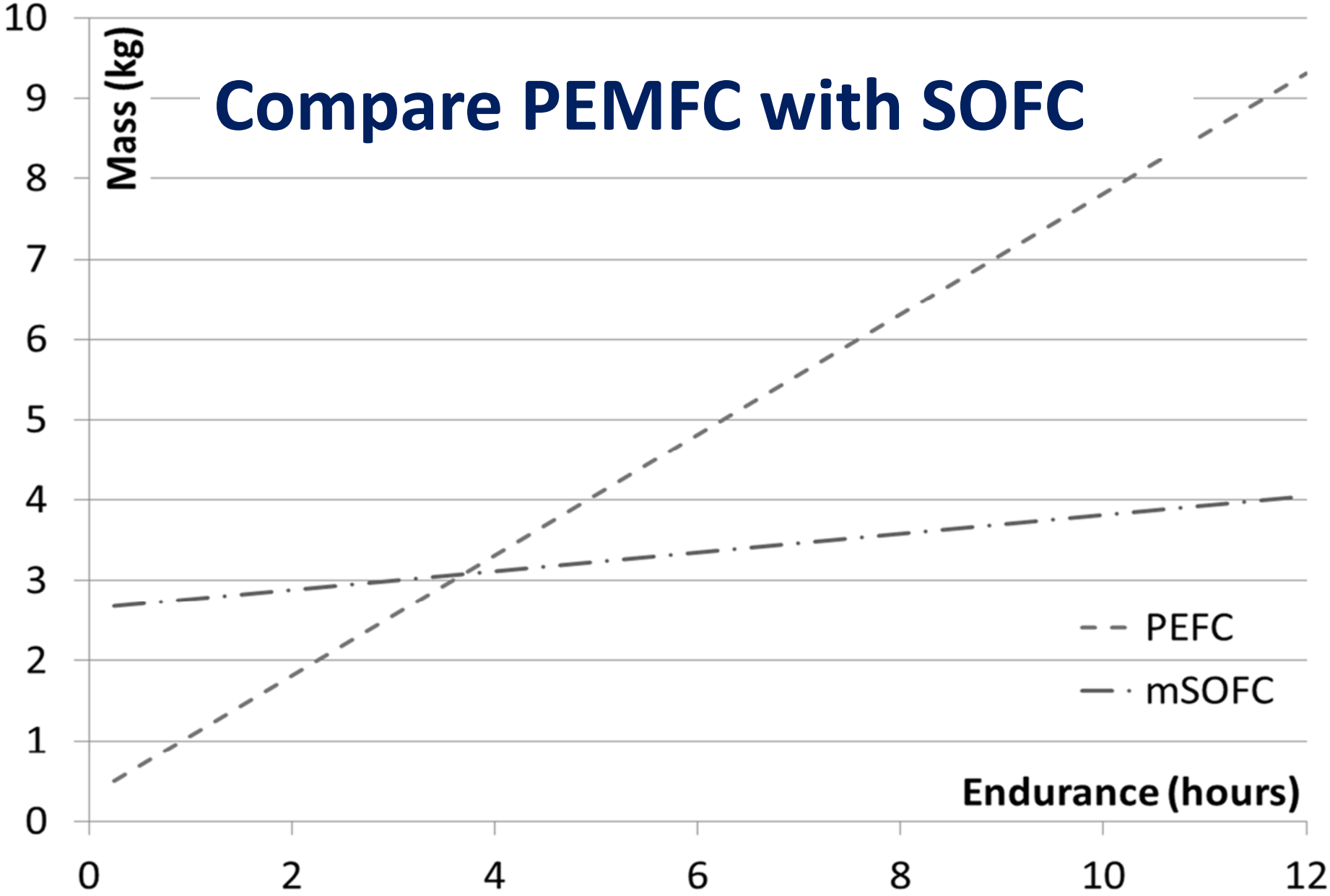
SOFC DEMONSTRATOR

UAVs powered by Fuel Cells

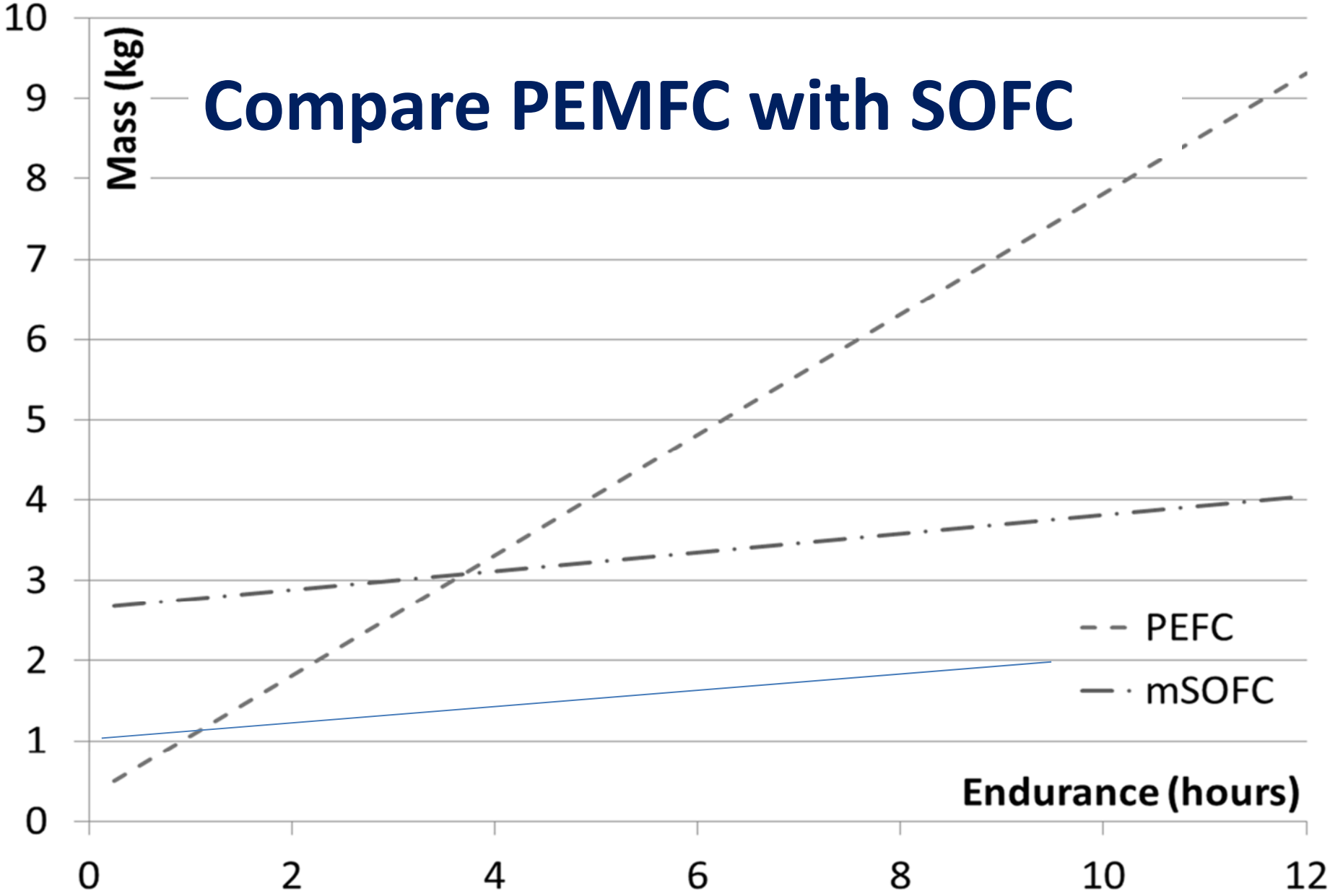
34 Polymer FCs
Eg HyFish

2 SOFC
Eg Lockheed-Martin Stalker

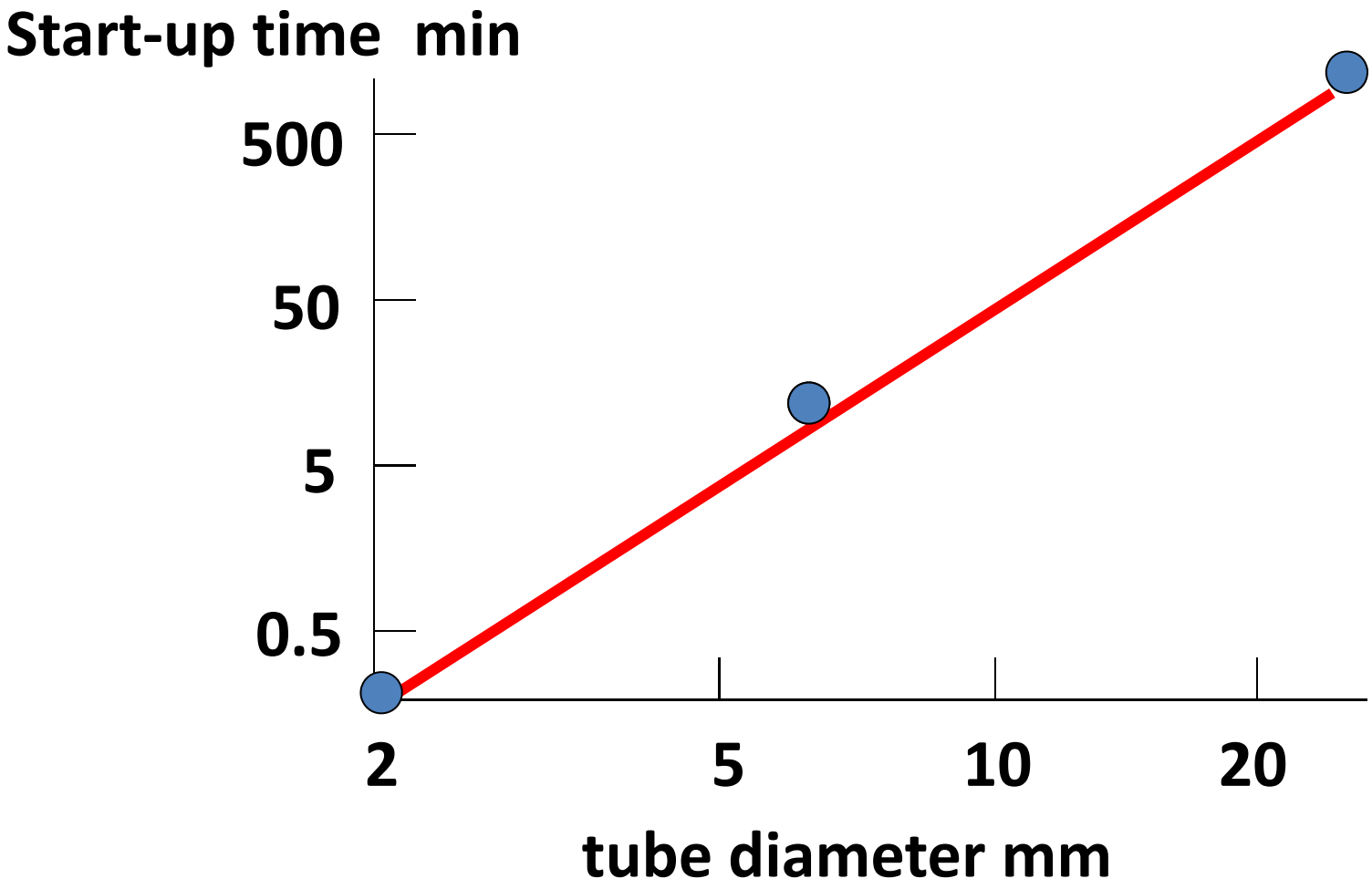
Compare PEMFC with SOFC



Compare PEMFC with SOFC

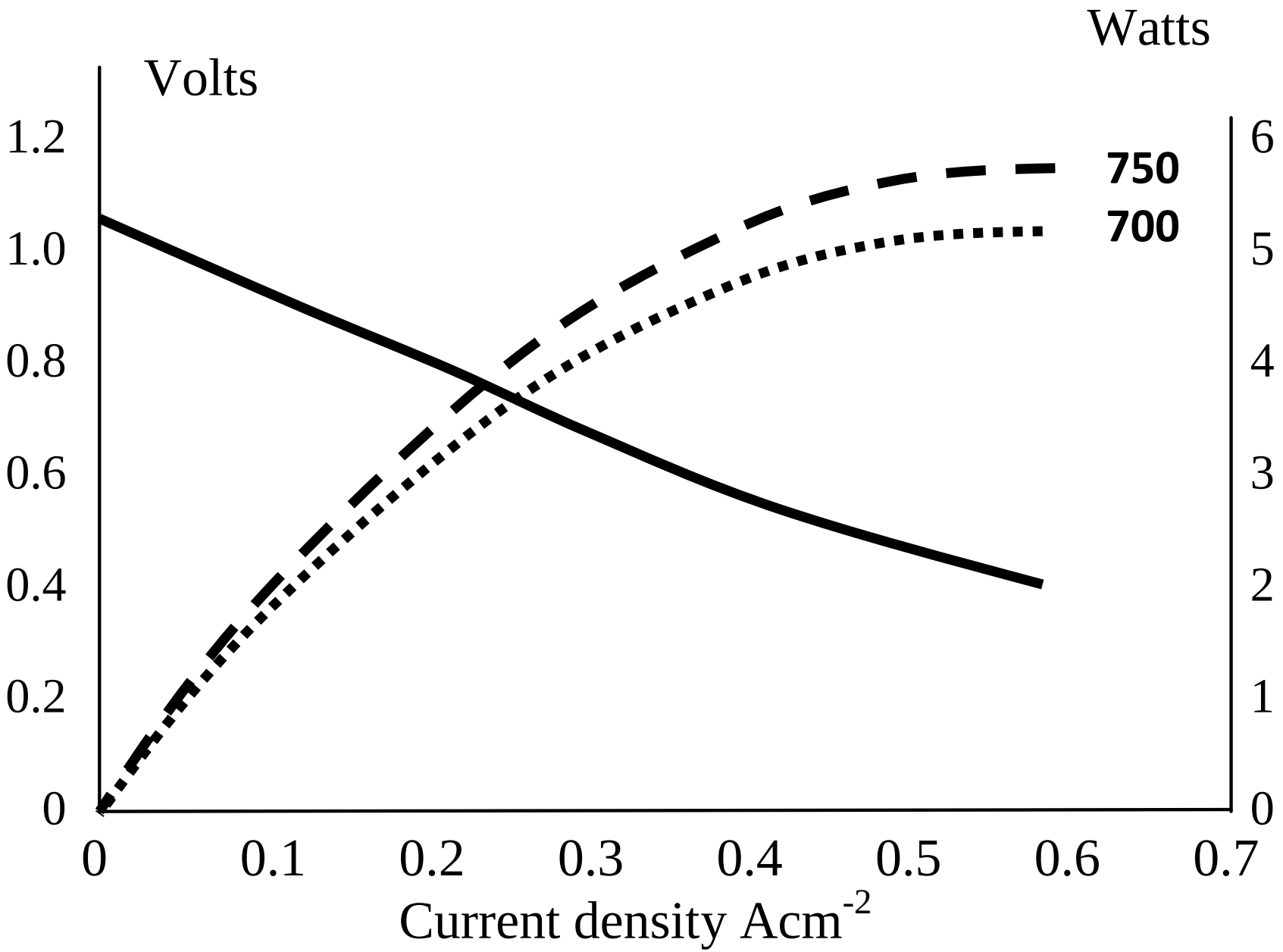


START-UP TIME vs TUBE DIAMETER

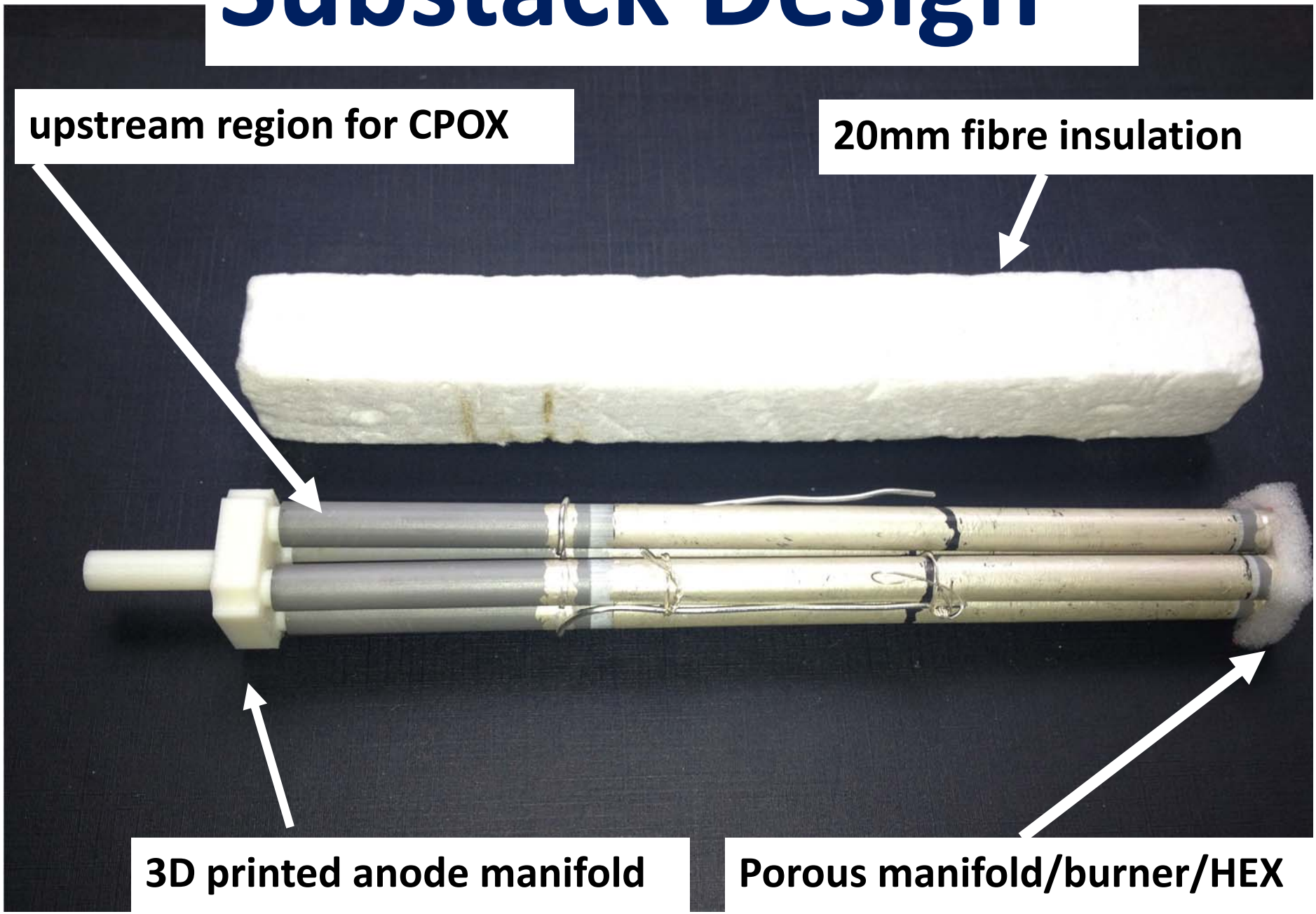


Cell test arrangement

SOFC performance



Substack Design



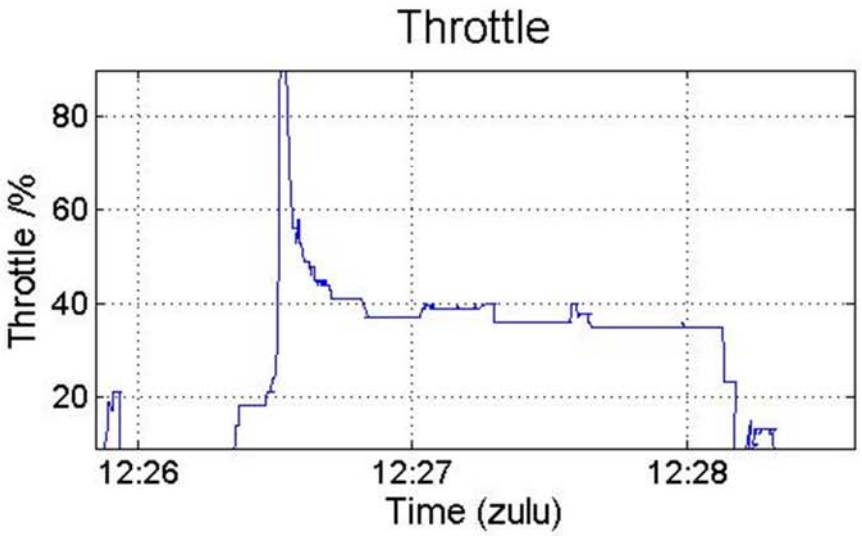
Skywalker plastic plane

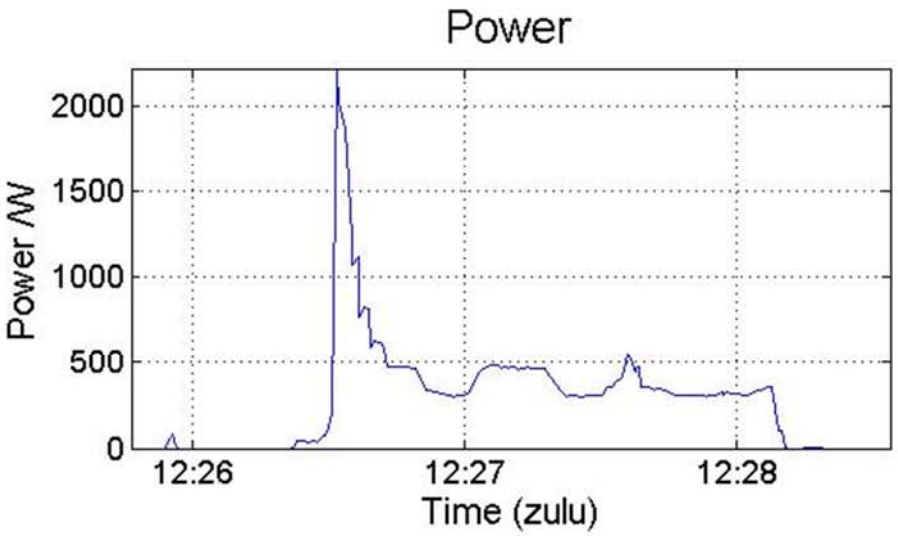
2 m wingspan UAV

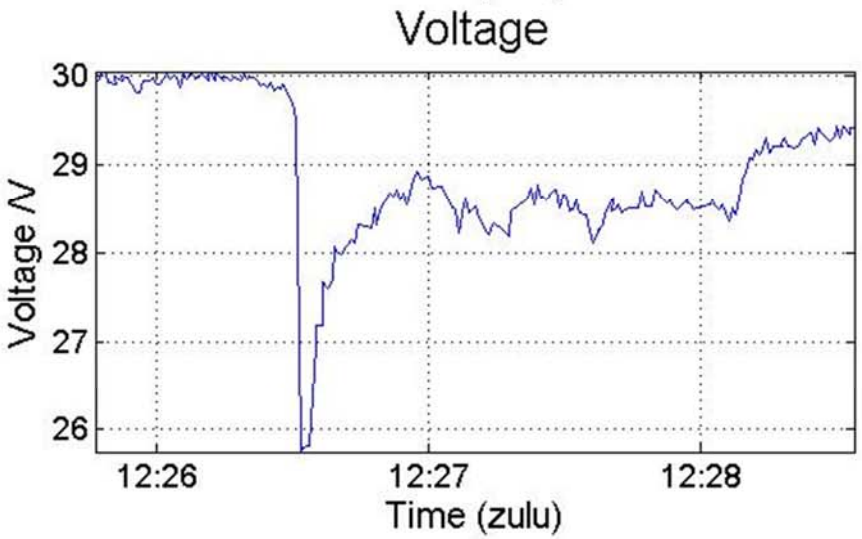
Testing UAV skywalker

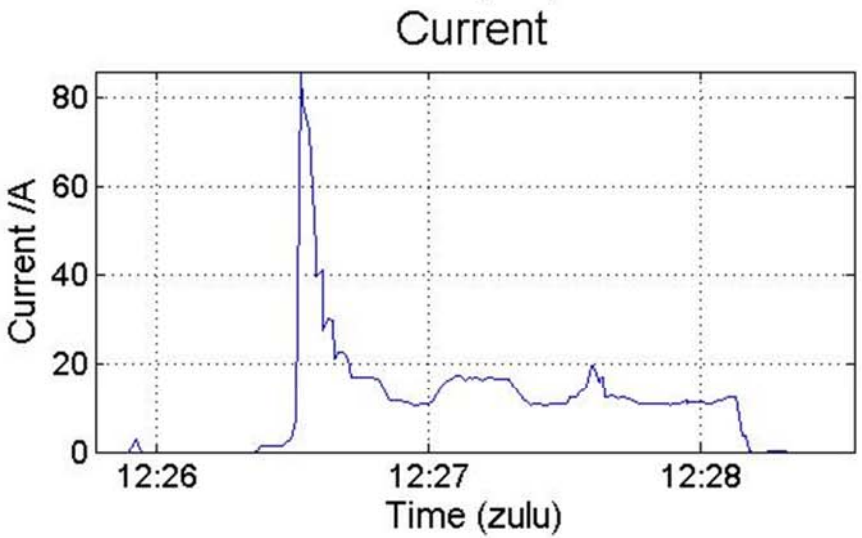
Skywalker X8 with SOFC + propane tank installed

Mission testing










Mission Planner 1.2.53 mav 1.0
Flight Data
Flight Planner
Configuration
Simulation
Firmware
Terminal
Help
Donate
UDP
115200
Link Stats...
Connect
105 120 SE 150 158 165 S 195 210
99%
12:02:36
AS 14.2
GS 15.3
Stabilize
190>0
Bat 0.03v 0 A 0.86%
GPS: 3D Fix
Quick
Actions
Gauges
Status
Telemetry Logs
Servo
VSI
Speed
Alt
Dir: 214
Vel: 3
119
hdop: 1.6
Sats: 9
52.7450496
-1.2197616
118.84
Tuning
Auto Pan
Zoom
17.4

SOFC UAV

CONCLUSIONS

- **SOFC UAV can operate on propane**
  - **10 min start; 100W/kg power density**
  - **Propane beats hydrogen by a factor 6**
- **UAV is successfully extended in range**
- **Lightweighting is key requirement**