



Investigation of H₂S Sorbent for Fuel Cell Application

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Acknowledgments

Army Organizations:

RDECOM, TARDEC, CERDEC

Contractors:

Altex, ASPEN, and PCI



Necessity of JP-8 Fuel to Electricity

-- Problem:

Electricity from internal combustion engine less desired vehicle application and more need for batteries

-- Solution:

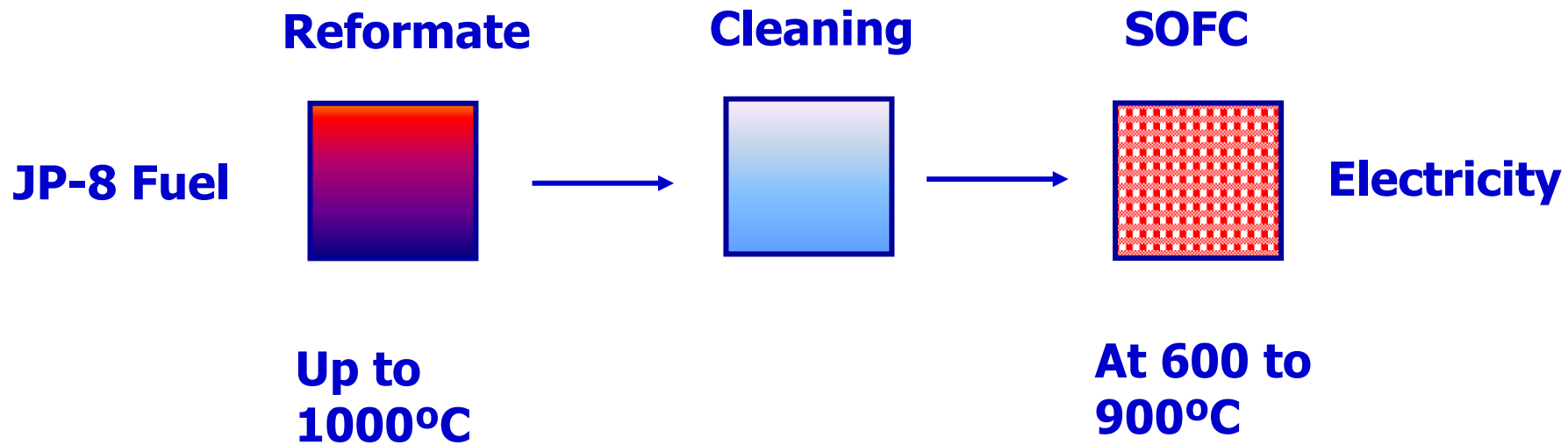
Development of technology for silent electricity generation and battery recharger through JP-8 reforming and fuel cell

-- Benefit:

Reduced logistic burden & enhanced Army's capability to accomplish its mission



Sulfur Removal

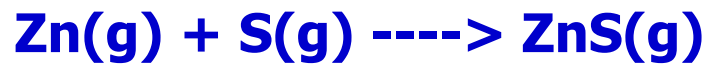




Sulfidation Reaction of ZnO



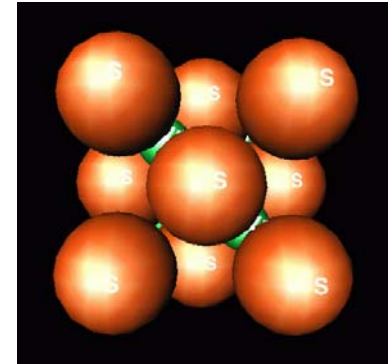
Stoichiometrical Capacity: 393 mg S/g



$\Delta H(298)$: -49.1 kcal/mol

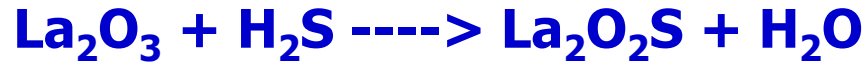
ZnO: P63mc 3.250, 3.250, 5.207, 2 (O: 0.60Å)

ZnS: P63mc 3.820, 3.820, 6.260, 2 (S: 0.94Å)

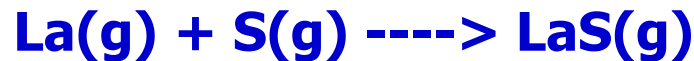




Sulfidation Reaction of La_2O_3



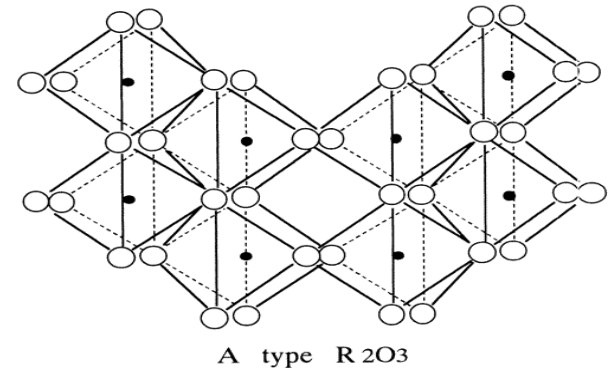
Stoichiometrical Capacity: 98 mg S/g



$\Delta H(298)$: -141 kcal/mol

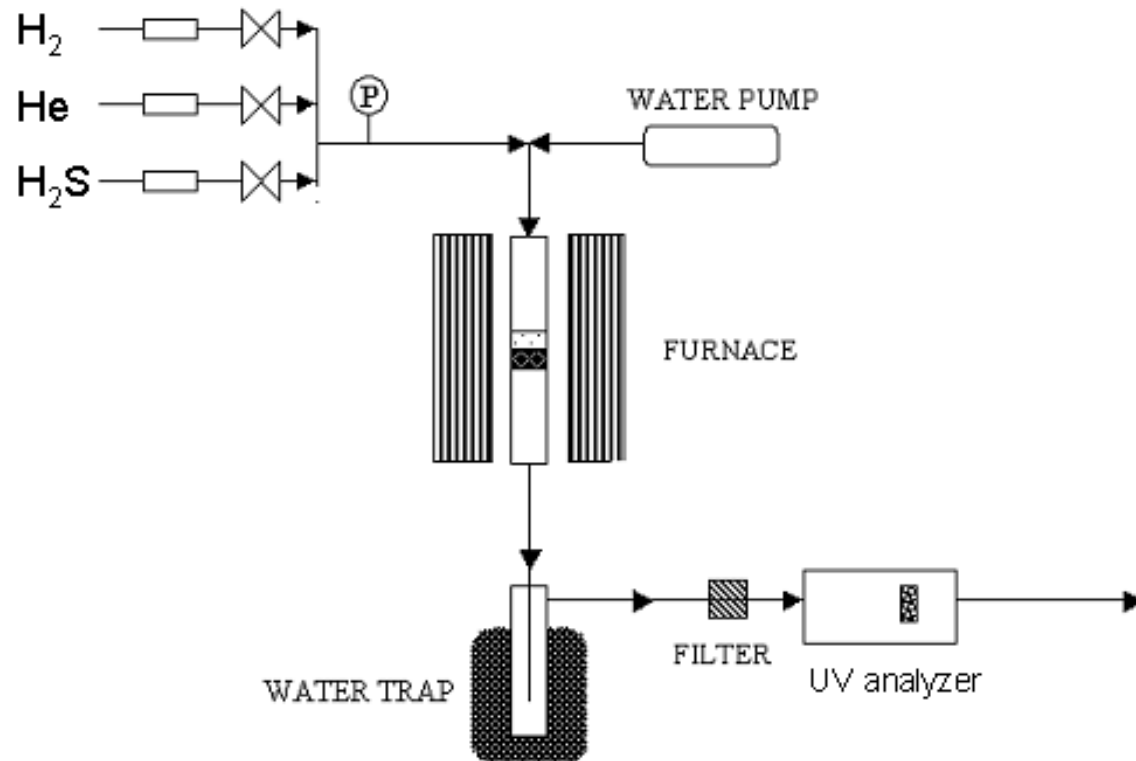
La_2O_3 : P-3m1 3.937, 3.937, 6.130, 1 (O: 0.60A)

$\text{La}_2\text{O}_2\text{S}$: P-3m1 4.051, 4.051, 6.944, 1 (S: 0.94A)



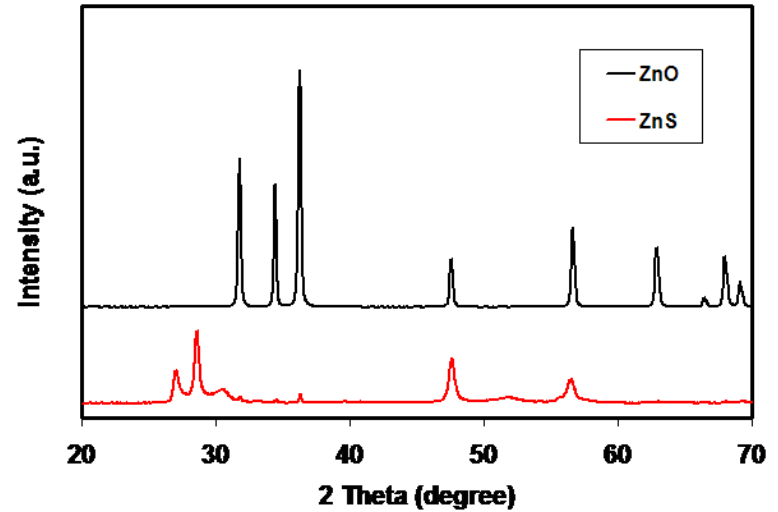
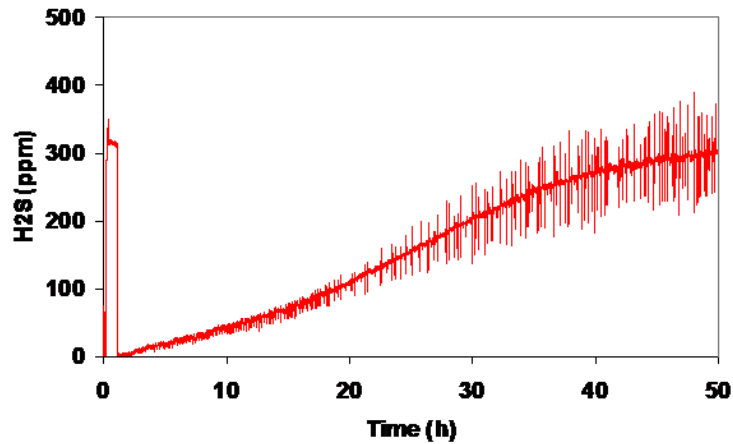


Desulfurization Reactor System





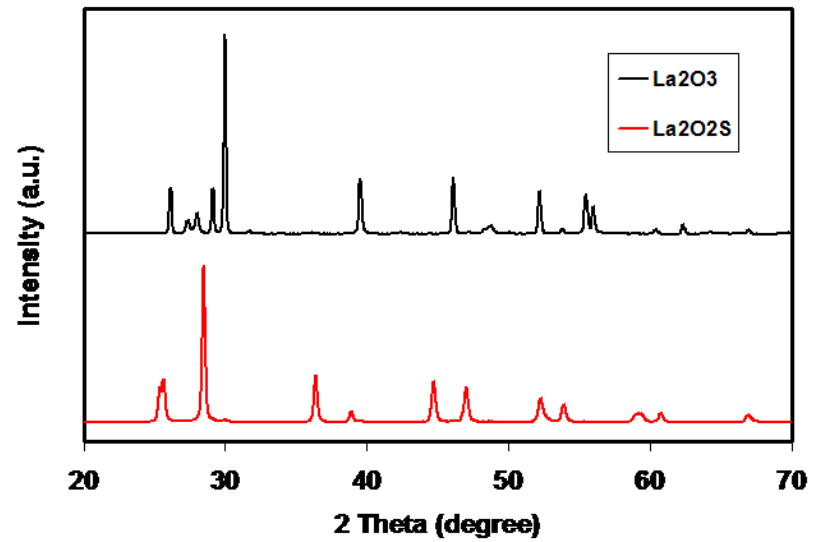
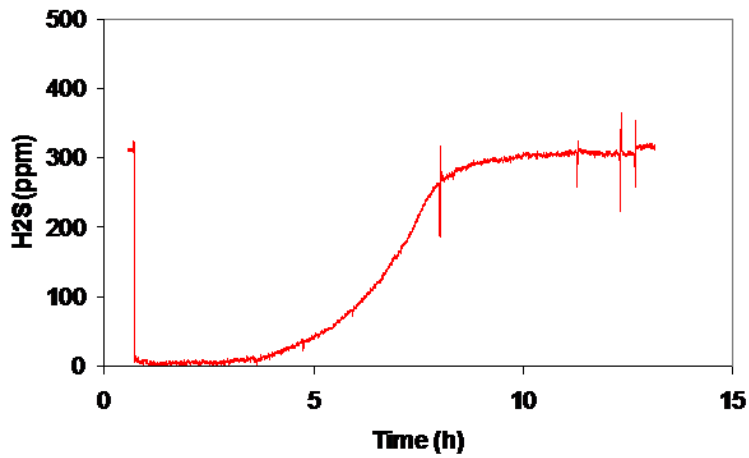
Sulfidation Results of ZnO



	Capacity (mg S/g)	BET (m ² /g)
350 °C	275 mgS/g (70 %)	ZnO 11.57 ZnS 12.08
500 °C	305 mgS/g (78 %)	



Sulfidation Results of La_2O_3



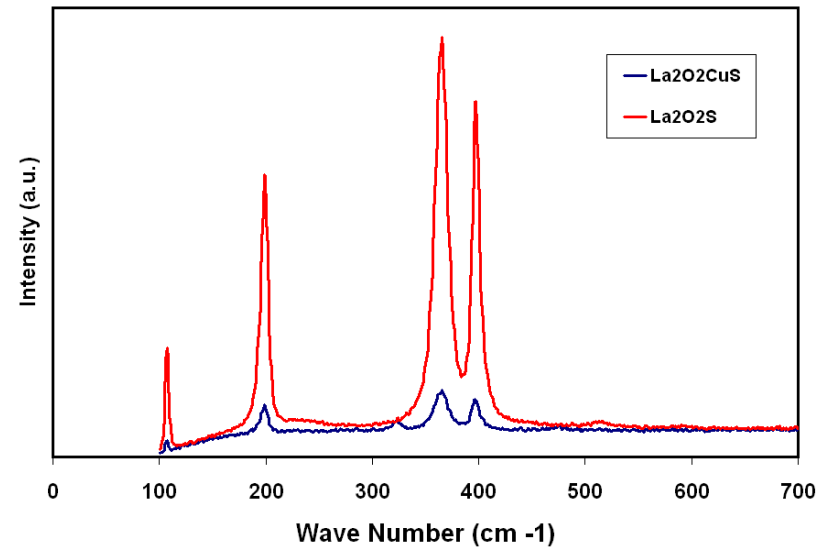
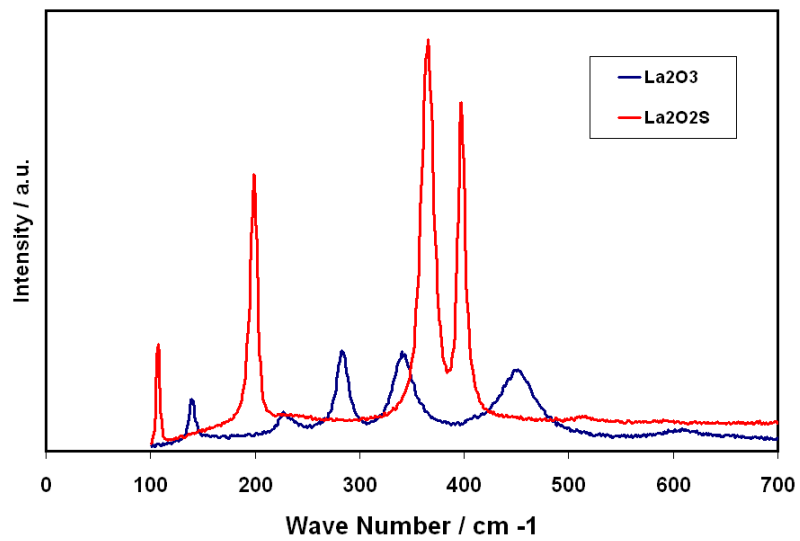


Results of Commercial & In House Prepared Samples

	Linewidth (2θ)	Capacity (mg S/g)	BET (m ² /g)	
La₂O₃ (commercial)	0.343 (16.4 μm)	61.47	La₂O₃	1.40
			La₂O₂S	1.71
La₂O₃ (in-house) 600°C	0.558	58.10	La₂O₃	7.82
			La₂O₂S	4.81
La₂O₃ (in-house) 700°C	0.648	72.20	La₂O₃	4.59
			La₂O₂S	3.99
La₂O₃ (in-house) 800°C	0.540	63.85	La₂O₃	11.59
			La₂O₂S	5.64

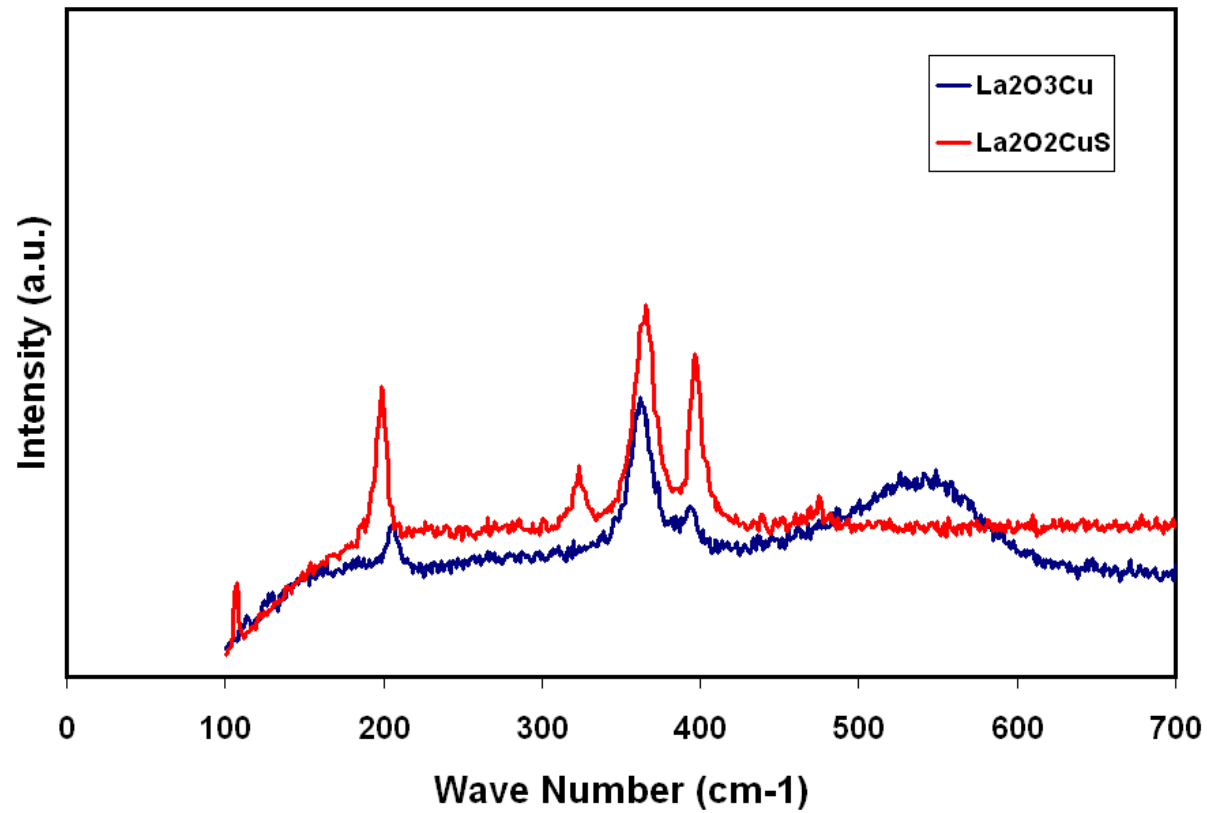


Raman Spectroscopy





Raman Spectroscopy





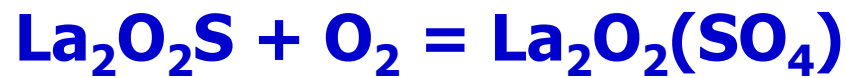
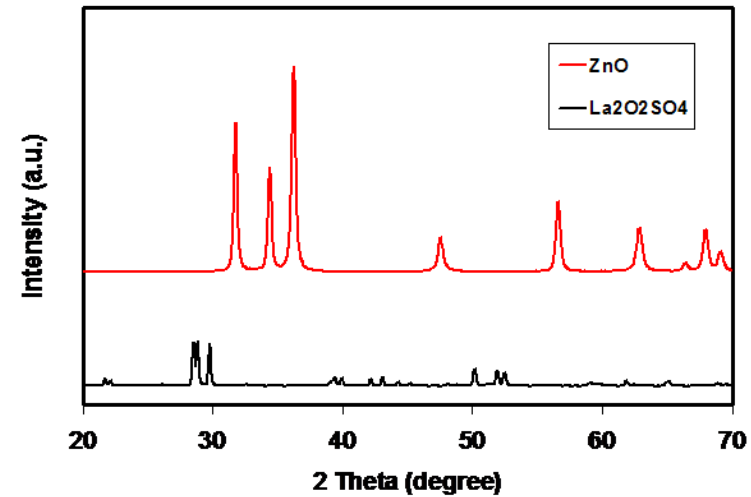
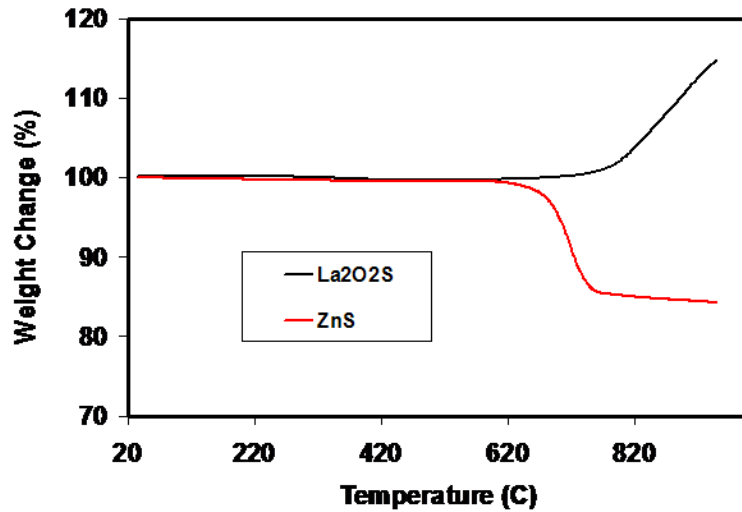
X-Ray Photoelectron Spectroscopy Results

Unit: eV

	La-Cu	La-CuS
La _{3d}	861.9 845.2	863.9 847.1
O _{1s}	540.0	541.5

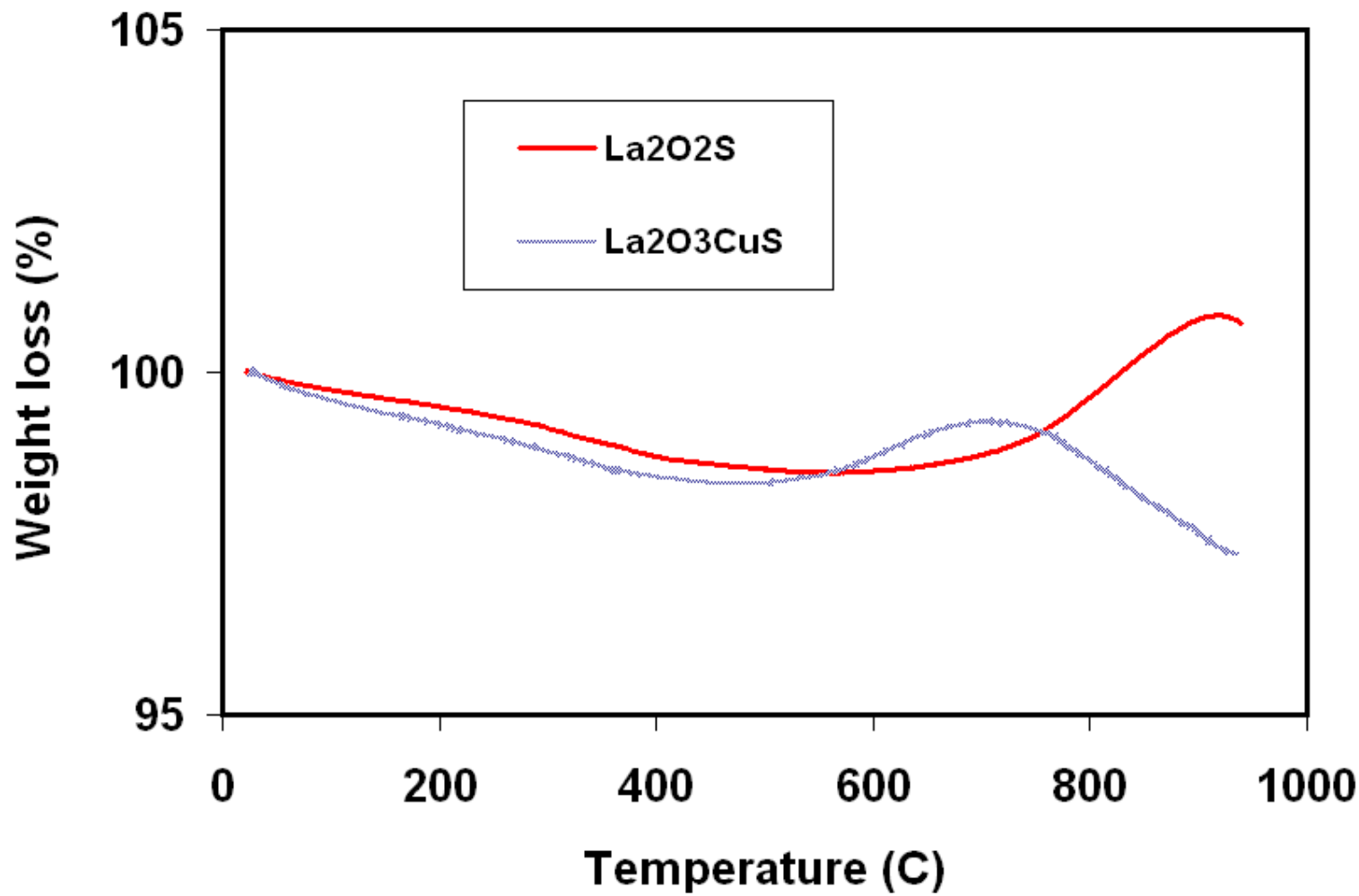


Sorbent Regeneration



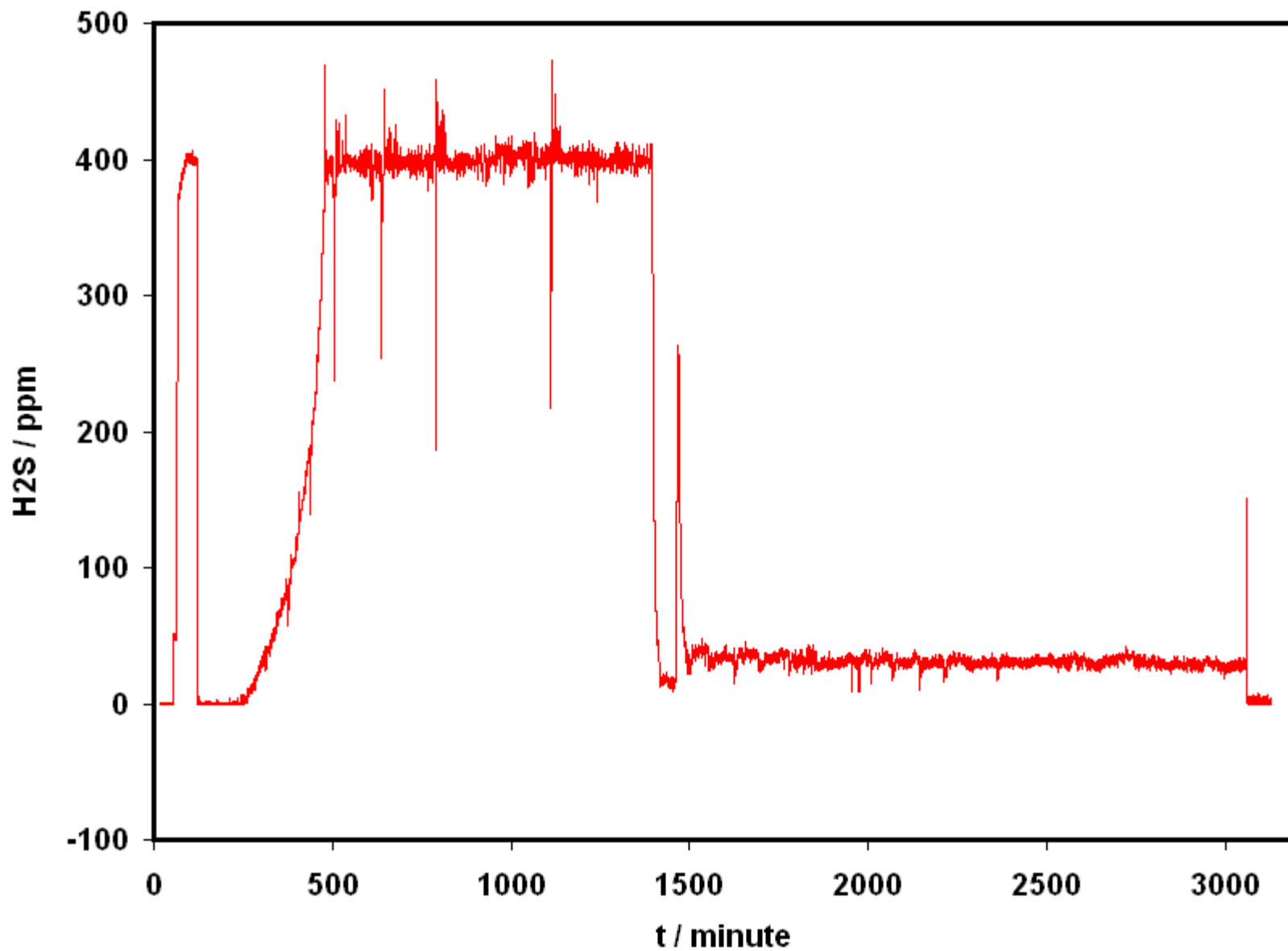


Possible Catalytic Regeneration



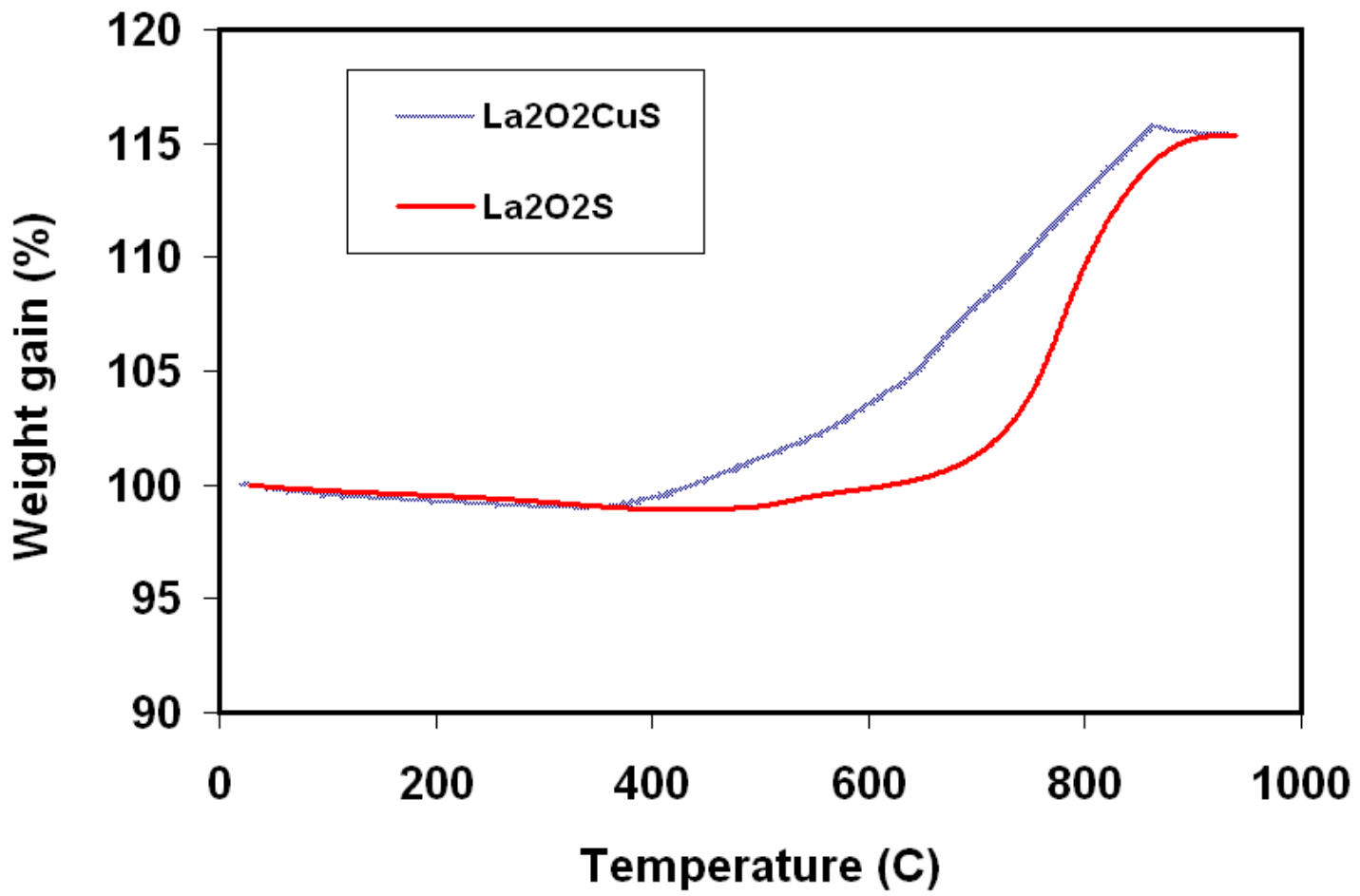


Regeneration



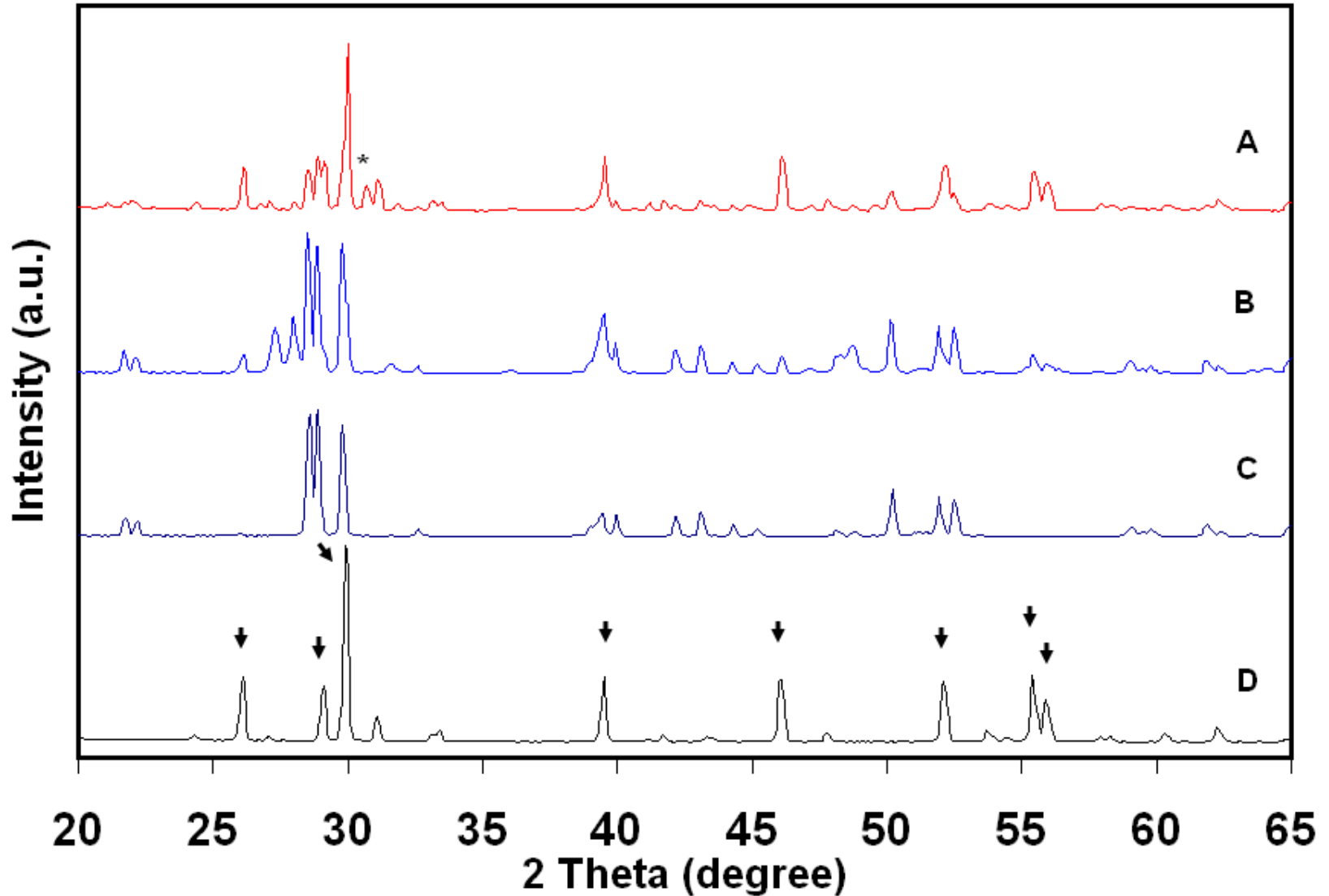


Catalytic Oxidation





X-Ray Powder Diffraction





X-Ray Photoelectron Spectroscopy Results

Unit: eV

	La-Cu	La-CuS	La-CuS @950°C
La_{3d}	861.9 845.2	863.9 847.1	864.2, 861.7 847.3, 845.3
O_{1s}	540.0	541.5	541.3, 538.2
S_{2p}		170.7	178.8



Altex Steam Reforming System



JP-8 fuel: 6.5 gallons per day
Water: 11.4 gallons per day
System weight: 195 kg
System volume: 470 L

Status: System has been delivered to ARL, installation and set up is in process, found one problem that the system needs more cooling capacity than originally specified by Altex, ARL laboratory is making the cooling supply available.





ASPEN CPOX Reforming System



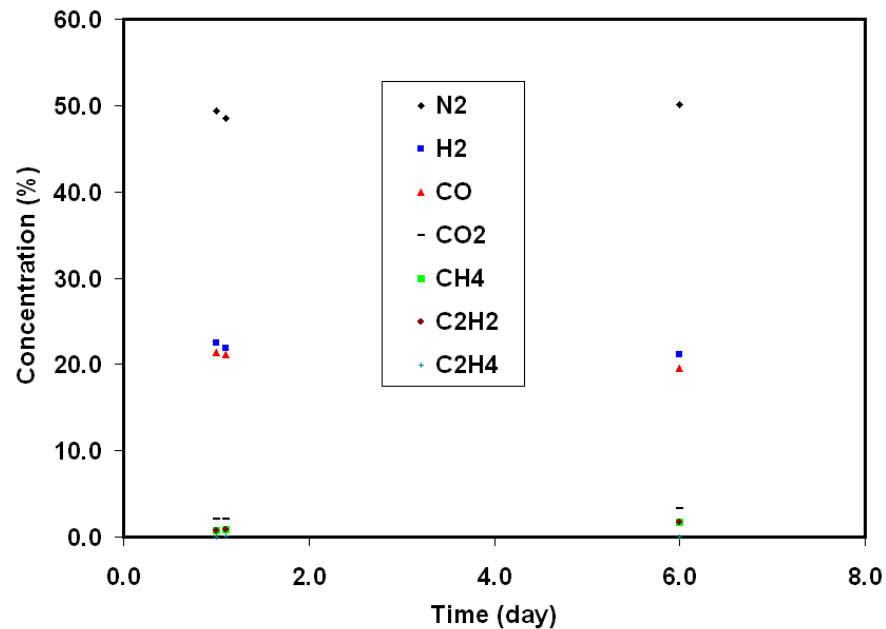
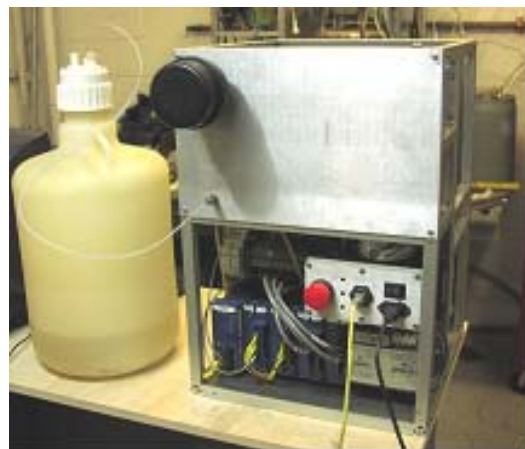
JP-8 fuel: 4.8 gallons per day

Water: 0 gallons per day

System weight: 32 kg

System volume: 96 L

Status: System has been delivered to ARL recently and installation/test is in process.





PCI Auto Thermal Reforming System



JP-8 fuel: 3.5 gallons per day

Water: 3.5 gallons per day

System weight: to be determined

System volume: to be determined

Status: has not been delivered



Summary

Altex: Steam Reformation Technology (SR)

Good R&D capability, delivered a prototype system to ARL on time. The system is larger (470L), heavy (195kg), and need 11.4 gallons water per day.

ASPEN: Catalytic Partial Oxidation Technology (CPOx)

**Good R&D and reformation system integration capability
Delivered seven Q reports, one final report, and a 2kW prototype system on time. The system weight and volume are 32kg and 96L, respectively.**

PCI: Auto-thermal Technology (ATR)

Good R&D capability, developed a 2 kW reactor and tested with a 1 kW SOFC stack, delivery is delayed.

ARL: Developed high temperature sorbent and filed a invention disclosure.