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INTRODUCTION AND GOALS

- ◆ Chicken feathers are important agricultural waste
- ◆ They have keratin based structure
- ◆ They are hollow tubes¹
- ◆ After pyrolysed their molecular structure changes but they conserve their hollow tube structure
- ◆ Carbonized (pyrolysed) chicken feathers fibers (CCFF) are rich in carbon
- ◆ CCFF have high surface area (450 m²/g) suitable for high H₂ storage capacities
- ◆ Department of Energy 2010 (DOE) Target
 - ◆ Gravimetric Capacity= 6 wt% H₂
 - ◆ Volumetric Capacity= 0.045 kg H₂/l
 - ◆ System Storage Cost= 4 \$/kWh

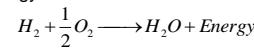


Hydrogen Powered Vehicle²

¹ C. K. Hong, R. P. Wool, Journal of Applied Polymer Science, 95, 1525 (2005)
² http://oml.gov/info/omlreview/v38_1_05/article06.shtml

HYDROGEN AS ENERGY CARRIER

- ◆ Why Hydrogen?
 - ◆ Clean reactant, no CO₂ emission in fuel cell
 - ◆ Energy density is ~3 times larger than gasoline¹
 - ◆ Fuel cells are at least 2 times more efficient than combustion engines²
- ◆ However, production and storage of H₂ are main bottlenecks for using it as an energy carrier.

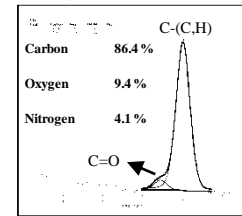
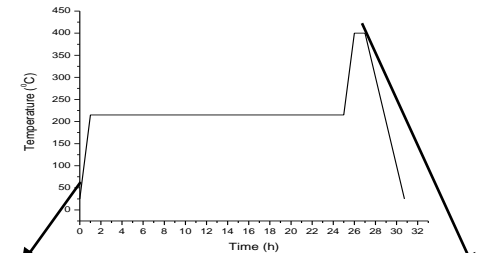


CURRENT INVESTIGATED TECHNOLOGIES ON HYDROGEN STORAGE

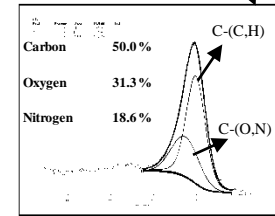
- ◆ Cryogenically stored liquid hydrogen
- ◆ High pressure vessels
- ◆ Solid metal hydrides (Chemisorption)
- ◆ Crystalline metal organic frameworks (MOF)
- ◆ Carbon Based Materials (Physisorption)
 - ◆ Graphite
 - ◆ Activated Carbon
 - ◆ Carbon nanotubes, nanohorns, nanofibers, etc.

¹ Louis Schlapbach, MRS Bull., 2002
² Jesse L. C. Rowsell and Omar M. Yaghi, Angew. Chem. Int. 2005,44, 4670-4679

CARBONIZATION OF FEATHER FIBERS

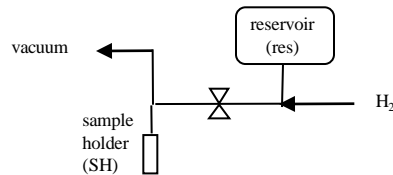


XPS C1s of Untreated CFF



XPS C1s of CCFF

SIEVERT'S APPARATUS FOR H₂ STORAGE

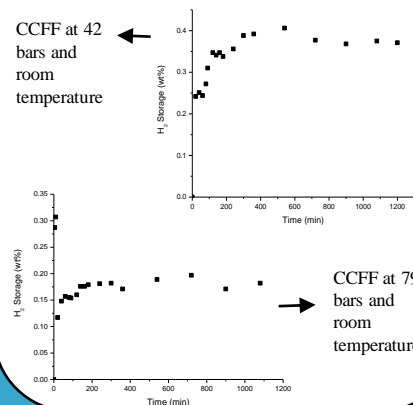


- ◆ Hydrogen gas is expanded from reservoir to sample holder. Pressure drop and temperature profile is monitored
- ◆ Initial Moles of H₂ (reservoir) = Final Moles of H₂ (reservoir + sample holder)

$$V_{res} \times d_{in} = (V_{res} + V_{SH} - V_{sam}) \times d_f + \frac{m_{ads}}{MW_{H_2}}$$

$$d = f(p, T)$$

H₂ STORAGE RESULTS



CONCLUSION

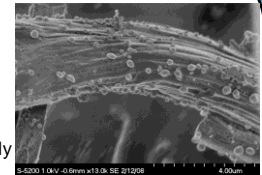
- ◆ XPS provided valuable information about the surface of fibers
- ◆ Surface of the fibers are not completely keratin
- ◆ The Sievert's apparatus is sensitive enough to detect adsorbed H₂
- ◆ Leak rate is within the limit of toleration
- ◆ Initial results from the equipment is consistent with the literature

FUTURE PLANS

- ◆ XPS provided valuable information about the surface of fibers
- ◆ Continuing searching for better pyrolysis paths
- ◆ Utilizing Tampered Element Oscillating Microbalance (TEOM) for crosschecking results

FUTURE PLANS (Cont'd)

- ◆ Investigating the effect of various dispersed metals on hydrogen storage
- ◆ Utilizing sufficiently low temperatures to reach DOE goal



SEM image of 10% Ag on CCFF taken in National Institute of Aerospace in Virginia

ACKNOWLEDGEMENTS

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