LUNCHTIME SEMINAR, NCN STUDENT LEADERSHIP COUNCIL
MSE 239, 11;30-1;15, 06/14/06

GIVING TALKS AND POSTERS THAT PEOPLE WOULD ACTUALLY LIKE TO SEE

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THE PROBLEM:

THE WORK THAT IS DONE IN THE NCN WHILE IMPORTANT TO THE FIELD OF NANOSCIENCE AND TECHNOLOGY IS NOT VERY EXCITING TO AUDIENCES HAVING GENERAL TECHNICAL EXPERTISE AND EVEN TO THOSE WITH RELATED TECHNICAL INTERESTS

THE TASK:

TO PRESENT YOUR WORK EITHER AS A TALK OR A POSTER IN SUCH A WAY THAT IS EXCITING AND INFORMATIVE USING A MINIMUM OF TECHNICAL DETAIL, AND WITHOUT UPSETTING YOUR THESIS ADVISOR

MYTH:

- MOST SCIENTISTS AND ENGINEERS THINK THAT WHEN THEY PRESENT STUFF IN PUBLIC THEY NEED TO IMPRESS THEIR AUDIENCES WITH COPIOUS AND TEDIOUS TECHNICAL DETAILS.

FACT:

- MOST ATTENDEES ONLY WANT TO SEE OR HEAR:
  - INTERESTING TALKS
  - THE HIGHLIGHTS OF THE WORK,
  - AND THEY WANT TO KNOW WHY THEY SHOULD PAY ATTENTION TO IT, i.e. WHY IT IS IMPORTANT!!!!

- THE SIN OF PRESENTING TOO MUCH TECHNICAL DETAIL IN TALKS OR POSTERS IS USUALLY LEARNED IN GRADUATE SCHOOL FROM PROFESSORS

- TECHNICAL PAPERS ARE ANOTHER MATTER

ALL TALKS AND/OR POSTERS SHOULD CONTAIN THE FOLLOWING ELEMENTS:

- **TITLE: SIMPLE AND AS NON TECHNICAL AS POSSIBLE, e.g.“A NEW SOAP FOR WASHING CARS”**
- **BACKGROUND: A SIMPLE TUTORIAL OF PREREQUISTE MATERIAL AND PRIOR ART NEEDED TO UNDERSTAND WHY WHAT YOU DID IS IMPORTANT, e.g. “PREVIOUS CAR SOAPS LEAVE STAINS IF NOT RINSED THOROUGHLY”**
- **WHAT YOU DID: e.g. “I WASHED A CAR WITH A NEW DETERGENT I DEVELOPED”**
- **THE MOST IMPORTANT RESULT(S): e.g. “MY STUFF LEFT THE CAR CLEAN AND STAIN FREE WITH MINIMAL RINSING’**
- **WHY THE RESULTS ARE IMPORTANT: e.g. “WE CAN NOW WASH OUR CARS USING MUCH LESS WATER”**
- **<u>OPTIONAL</u> APPENDIX OF TECHNICAL DETAILS**

THE OVER ARCHING RULE:

USE THE "KISS" METHOD:

"KEEP IT SIMPLE STUPID"

- **LESS IS MORE**
- **SEPARATE THE MAIN MESSAGE FROM THE TECHNICAL DETAILS**
- **>95% OF EXTERNAL TECHNICAL AUDIENCE WILL NOT HAVE ANY EXPERTISE IN YOUR WORK**
- **BE ABLE TO EXPLAIN WHAT YOU DO TO YOUR TECHNICALLY ILLITERATE MOM**

EXAMPLE OF AN INTERESTING TITLE

A NEW, SAFE, SCALABLE, ON-DEMAND, ECONOMICALLY VIABLE TECHNOLOGY TO MAKE HYDROGEN USING ALUMINUM

EXAMPLE OF A BORING TITLE

THE KINETICS AND DYNAMICS OF THE REACTION OF AL ALLOYS WITH H_2O IN THE GENERATION OF H_2, AL_2O_3, AND HEAT WITH IMPLICATIONS CONCERNING RELIABILITY, SAFETY, SCALABILITY, AND ECONOMIC VIABILITY

A NEW, SAFE, SCALABLE, ON-DEMAND, ECONOMICALLY VIABLE TECHNOLOGY TO MAKE HYDROGEN USING ALUMINUM

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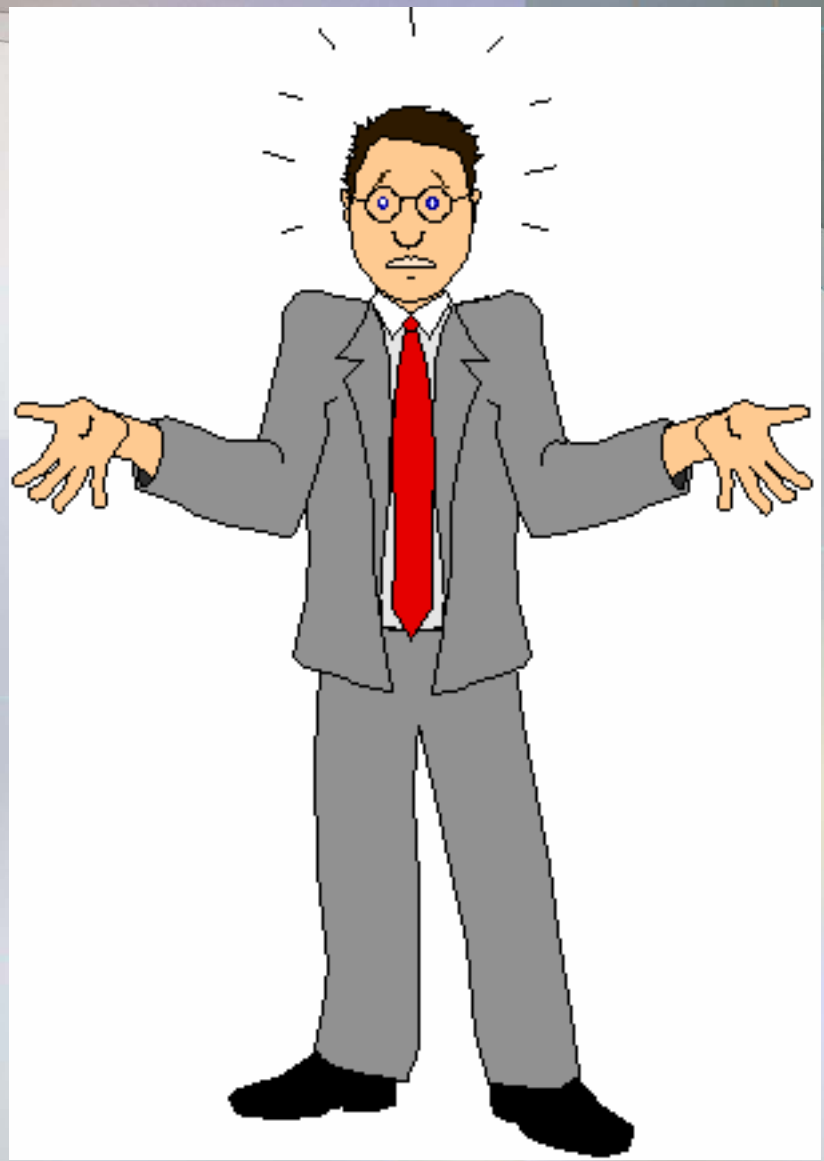
FOSSIL FUEL, e.g. OIL

A major source of *economically viable*

ENERGY and FUEL

But its abundance is finite and, if used for energy storage, not recyclable

“So, what are we gonna do when fossil fuels are no longer viable”



We're going to switch to alternative energy sources, including hydrogen, before fossil fuels are no longer viable

Hydrogen is great stuff:

- There's lots of it, e.g. lots of water
- Its combustion and chemical energy products are free of hydrocarbons
- It has a high energy content - 3x that of oil per unit weight (STP)
- It's recyclable, especially as water

But……

"Currently hydrogen fuel cells require highly expensive platinum, so they are not economically viable. The biggest technological obstacle to their use, though, is that hydrogen is a highly volatile gas that is hard to store, transport, and use safely. NO ONE HAS YET FIGURED OUT HOW TO PROVIDE HYDROGEN TO TENS OF MILLION MOTORISTS WITHOUT GREAT RISK."

"The Car of the Future" article
***The Week* magazine, April, 7 2006**

Advantages to using aluminum

- Aluminum is safe in air at room temperature
- Aluminum can make hydrogen on demand; little or no hydrogen gas storage needed
- No hydrocarbons in reaction products
- Spent aluminum (alumina) is recyclable!
- Same energy content per unit weight of oil (about 20K BTUs or about 6kW-hrs/lb.)
- Nearly infinite supply - 25 trillion lbs. reserve
- Enough known reserves to make nearly 150 trillion kW-hrs. of energy, or 75 x current annual U.S. electricity use (2 trillion kW-hrs)

Challenges

- Aluminum loves oxygen; air plus Al produces alumina
- However, a skin of alumina (Al_20_3) on solid aluminum protects Al from further rapid oxidation, hence, its usefulness as a construction material
- If this passivating oxide could be disrupted, the Al would react with water to produce hydrogen:

$$\underline{2Al} + 3H_20 \text{ --> } 3H_2 + \underline{Al_2}\underline{0_3} + \text{heat, } \Delta F << 0$$

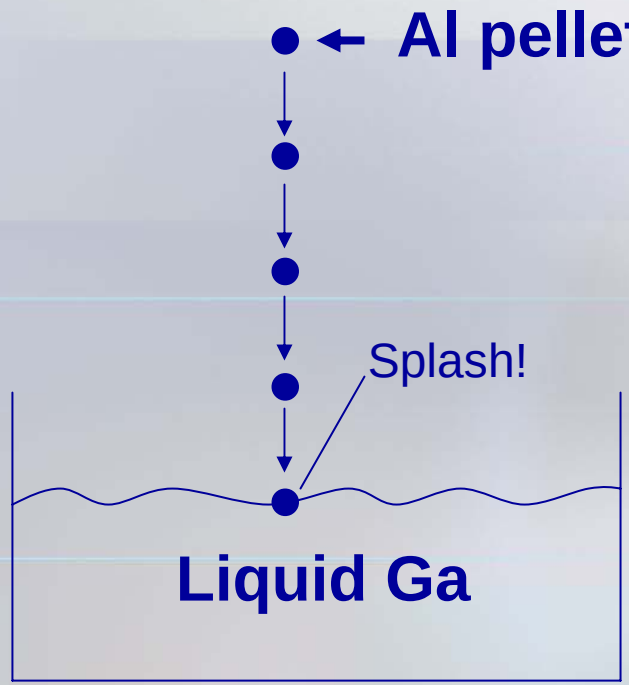
- This happens when water comes in contact with molten Al (Ka-boom!!)

A Solution

- A better oxide disruption method is to dissolve the Al into an inert liquid at or near room temperature
- This can be done at slightly above room temperature by dissolving Al into liquid gallium (Ga)
- Then bringing this liquid alloy into contact with water to generate hydrogen via reaction (1):

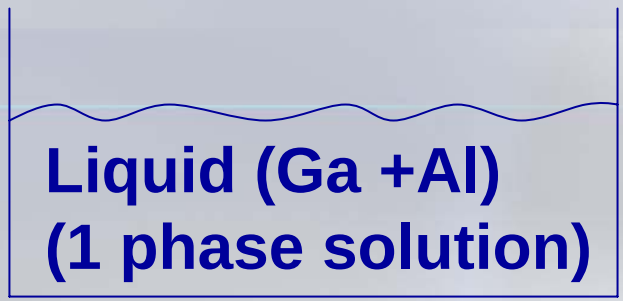
Making Hydrogen From Aluminum

STEP 1. - Add Al to Ga melt,for example:



Making Hydrogen From Aluminum

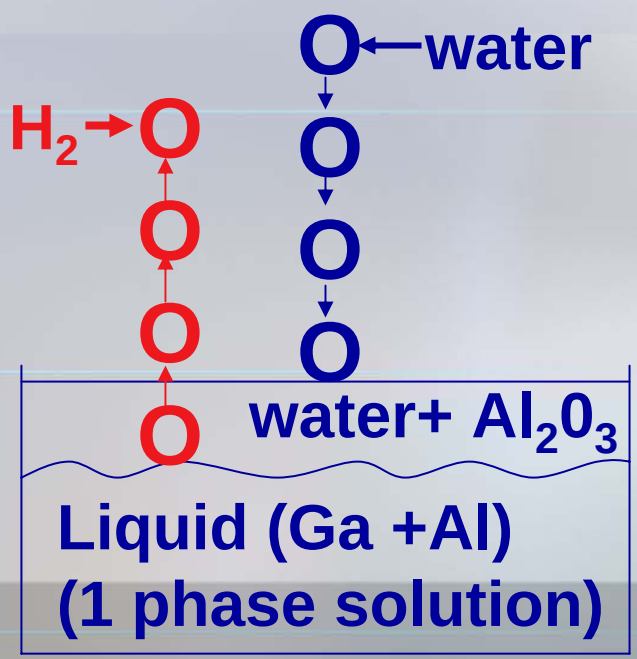
STEP 2. - Let Al dissolve into the Ga melt



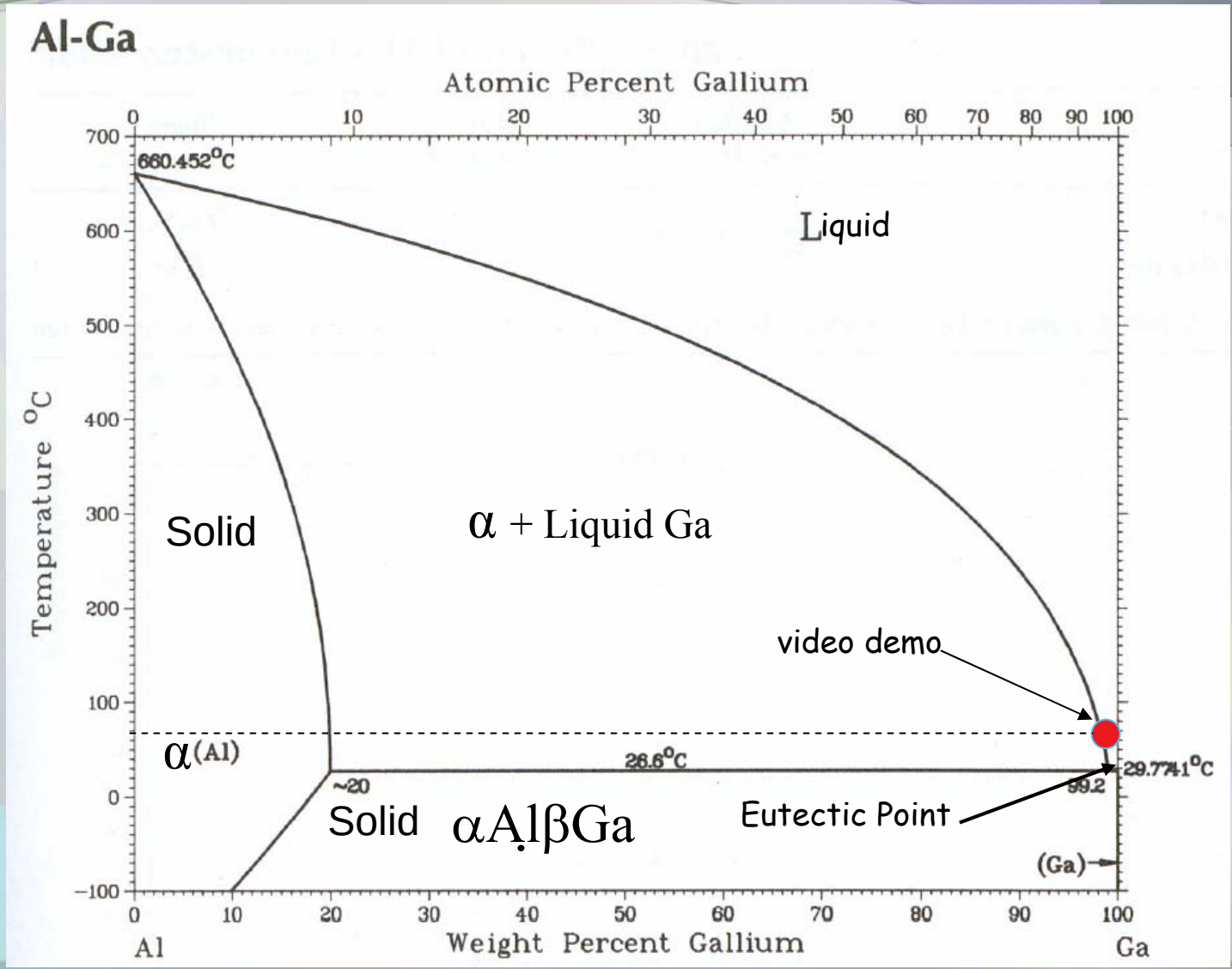
Making Hydrogen From Aluminum

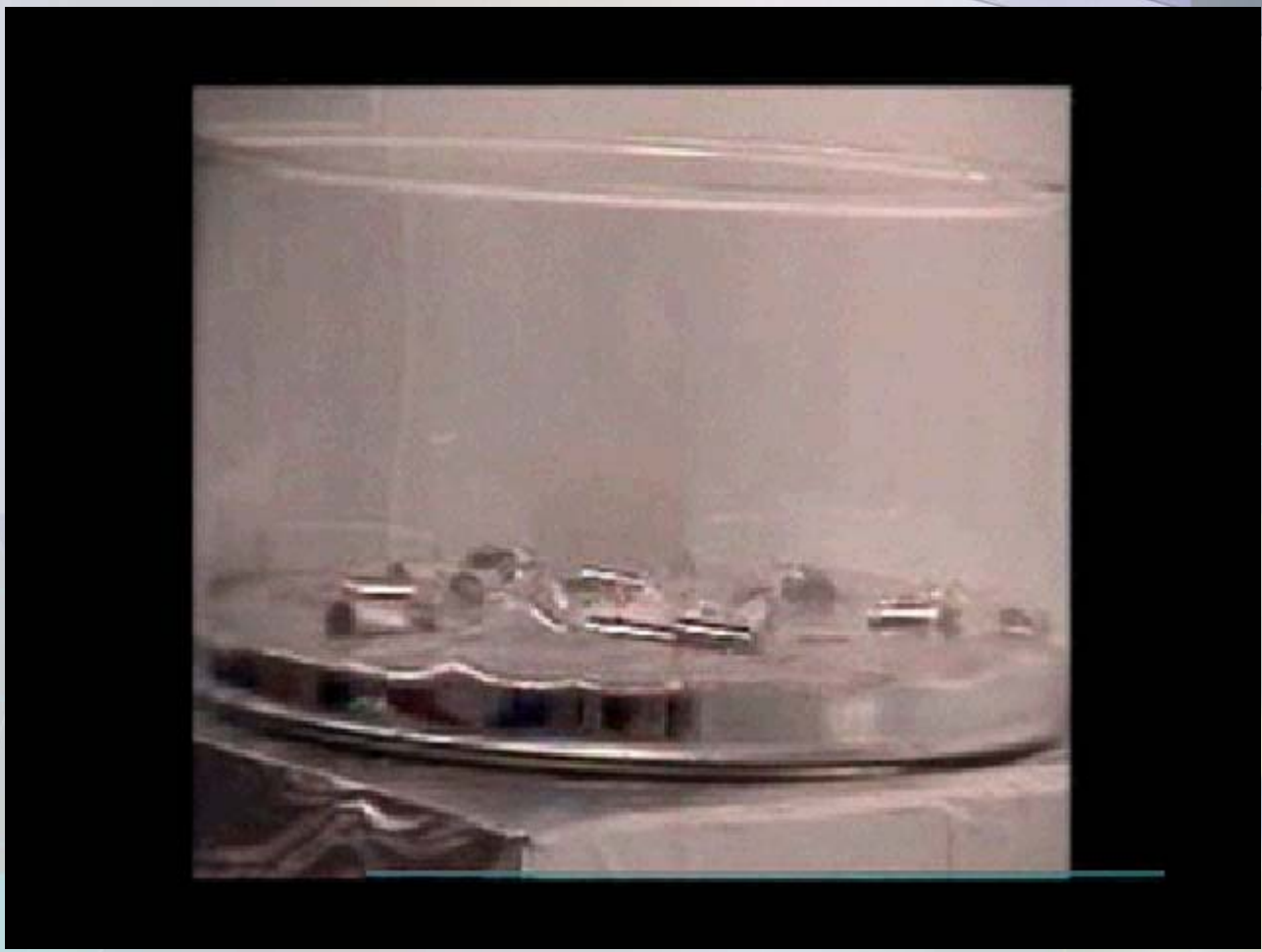
STEP 3. - Add water and stand back!

Water reacts with Al at the water-alloy interface and generates hydrogen; Al_20_3 forms a gel in the water; the hydrogen is collected for further use; Ga is inert and can be recovered along with the Al_20_3



Phase Diagram: Al-Ga





Energy needed to reduce alumina to aluminum

- The reaction of Al with water to produce hydrogen, alumina and heat is:

  $2Al + 3H_2O \dashrightarrow Al_2O_3 + 3H_2 + heat$

- The electrochemistry of reducing Al (in alumina) is:

  $Al^{+3} + 3e^- \dashrightarrow Al$, and requires about 12 kW-hr./lb of Al at a present process efficiency of 50%

Cost of H_2 made by Al compared to gasoline in cars with internal combustion engines

- 2x wt. Al has same energy content (as hydrogen) as 1x wt. gasoline
- It takes 20 gal. x 6.5 lbs./gal = 130 lbs. gasoline to drive an average car 350 mi, or 260 lbs, Al
- At $3.00/gal for gasoline and $0.70/lb. for Al, the trip costs $60 using gas and $182 using Al (ouch!)

Cost of H_2 made by Al compared to gasoline in cars with internal combustion engines

However…

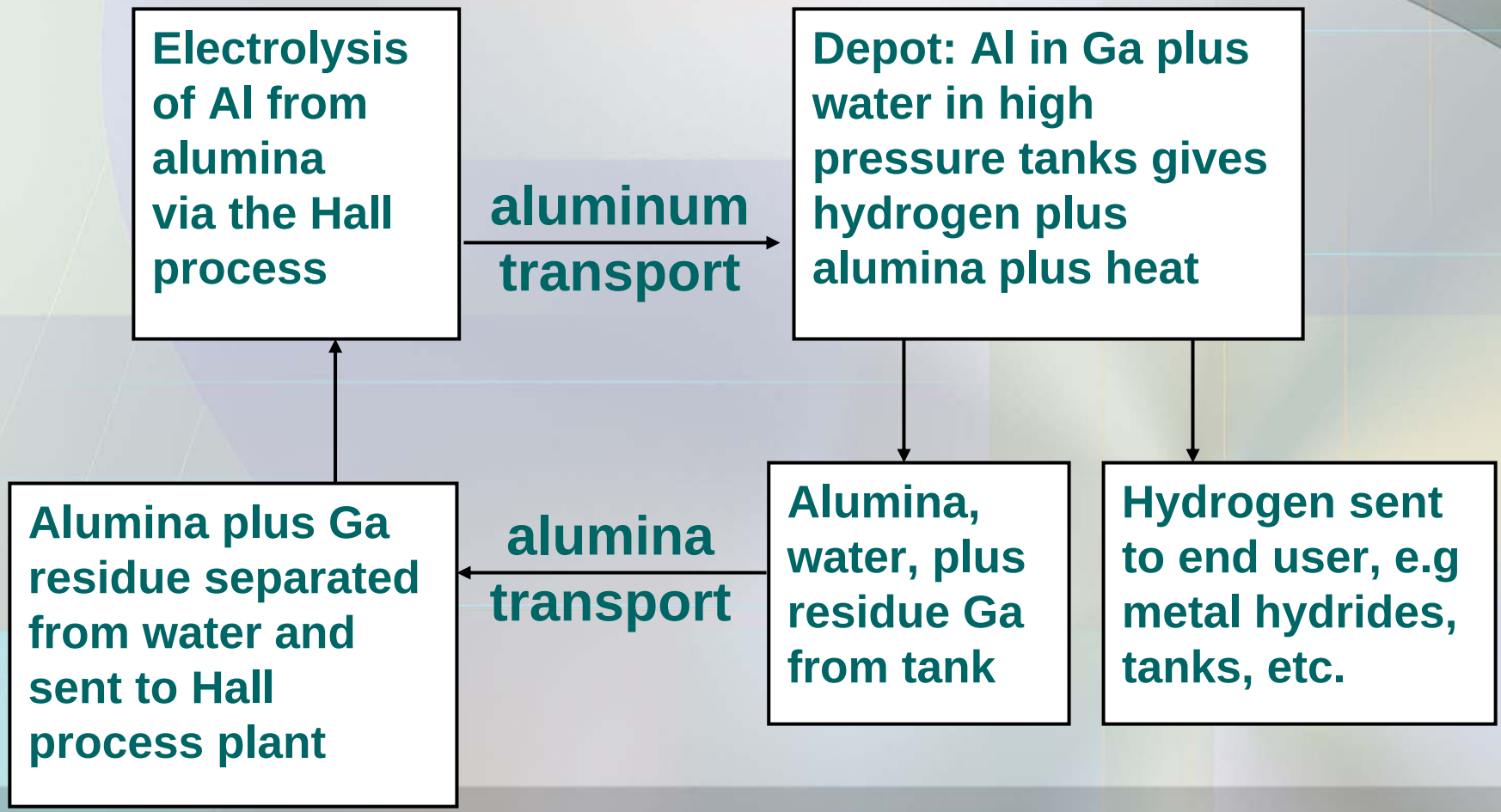
If an Al recycler is built next to a nuclear power plant with an on-site power cost of $0.02/kW-hr, it can recycle the alumina for:

12 kW-hr/lb. x 260 lbs. x $0.02/kW-hr

or about $62 per 350 mi trip* using Al!

*** For the long term Al recycling will be done at solar photovoltaic farms.**

A Universal Application Process Overview



Bottom Line

- Al-Ga alloys react with water to produce H_2
- Proven science, with no technology barriers
- Hydrogen mass density - 6% (mobile use)
- Energy (as H_2) vol. density 18 Kw-Hr/liter
- Conversion efficiency - 50% (Al_2O_3 to Al), 100% (Al to Al_2O_3), 15% cyclic for ICE apps.
- Al is the storage, energy transport,and conversion material to make hydrogen
- Ga is inert and *totally* recoverable and can be low purity, hence cheap

Commercialization/Collaboration

- Seeking established companies who might be interested in collaborations and/or funding further research into this innovation
  - This will allow both maturation of science and development of technology prototypes

- Potential start-up opportunity - Algalco
  - Seed funding
  - Graduate student assistance

To see a talking head "Breeze" version plus video go to http://hydrogen.ecn.purdue.edu and click on first line spot

Questions