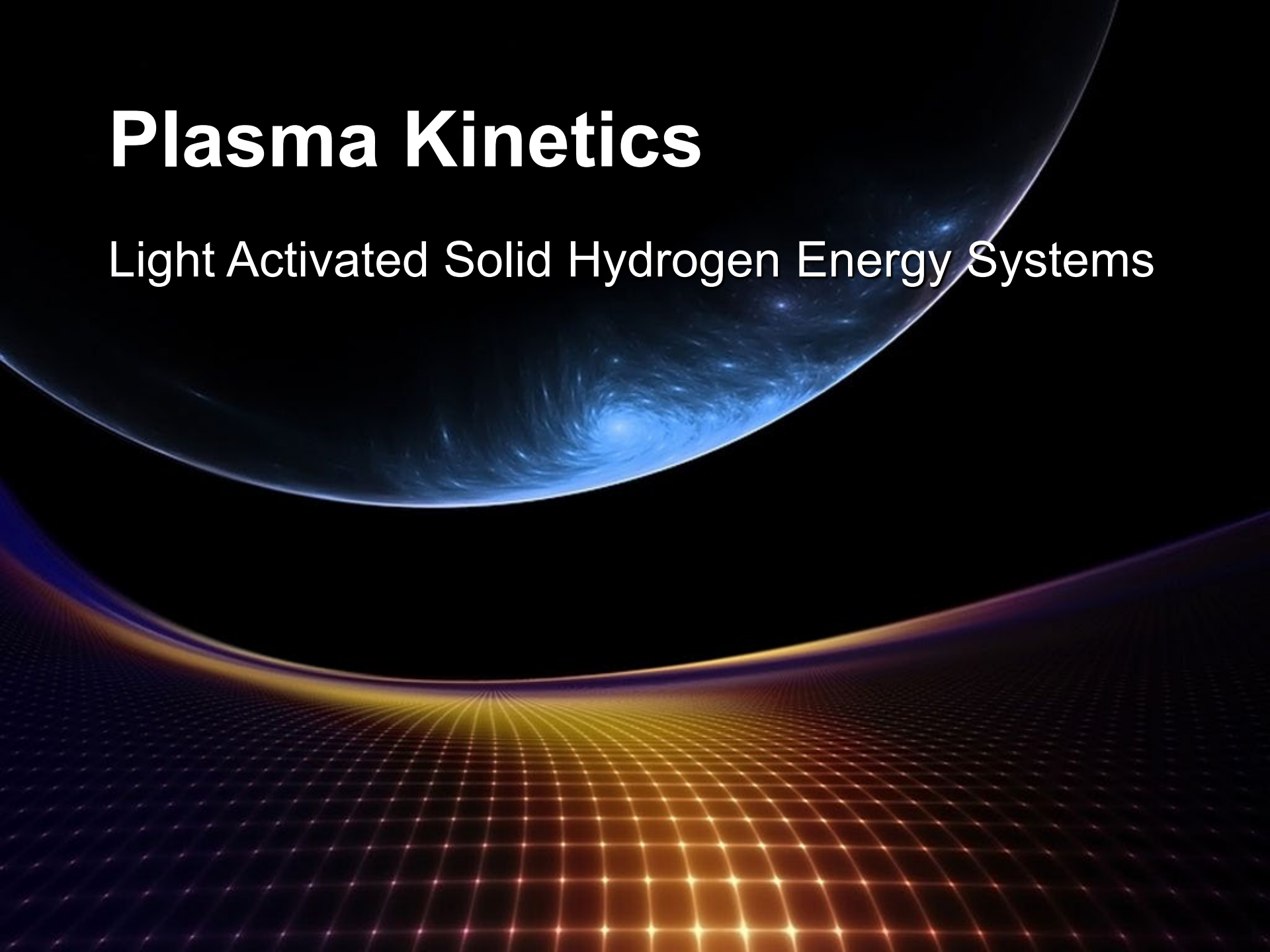


Plasma Kinetics

Light Activated Solid Hydrogen Energy Systems





Introduction

The world faces a staggering challenge of decarbonizing the global economy. Hydrogen is playing an important roll in the renewable energy arena and could account for almost one-fifth of total final energy consumed by 2050. Despite being the most abundant element in the universe and an absolutely clean energy resource, its adoption has been slow due to available choices in technology to capture, transport and distribute hydrogen in terms of cost, safety and efficiency.

Plasma Kinetics has developed a light activated solid hydrogen technology that will allow hydrogen to not only compete with its compressed and liquid forms and batteries, but replace fossil fuels in certain market segments on a cost and efficiency basis – and without subsidy. Our solid hydrogen solutions require no new expensive infrastructure for deployment in distributed markets and further can be configured as an end-to-end supply chain by capturing, storing, transporting and dispensing hydrogen more efficiently than other competing system. Our process has been validated by three independent institutions and scalable prototypes have been tested.

We are now seeking commercial and institutional partners and contracts to deliver market-specific systems on a shorter timeline than government mandates and at a lower cost than estimated by market analysts.



Mission

“To be a leader in building a responsible and safer global hydrogen economy.”



Technology

Light Activated Hydrogen Energy Storage

- Patented Nano-Structured Magnesium Hydride Film Technology
- Low pressure and low temperature capture of hydrogen gas
- Dense, non-combustible solid storage
- Transport and distribute in small to large canisters
- Release hydrogen gas at point-of-use on demand with laser light
- Reusable canisters holding storage medium are "rechargeable" up to 1000 times
- New scalable end-to-end hydrogen solutions



Technology Advantages

- Stores hydrogen indefinitely with no maintenance
- Light weight (high energy density)
- Materials are 100% recyclable
- Quick recharging (5 minutes) or hot swappable canisters
- Rechargeable from green by-product hydrogen sources
 - Municipal waste-water treatment plants
 - Municipal incineration facility or burn pit
 - Potable water electrolysis
 - Industrial flue gas
 - Chemical production (ammonia, naphtha reforming, ethylene)
- No major infrastructure required for full scale adoption



Technology vs. Lithium Batteries

- More economical than batteries
- More energy than batteries
- Lighter than batteries
- Smaller than batteries
- Zero emission generation of energy
- Stores indefinitely without maintenance
- No self-discharge
- 100% recyclable materials vs. battery 4% recyclable

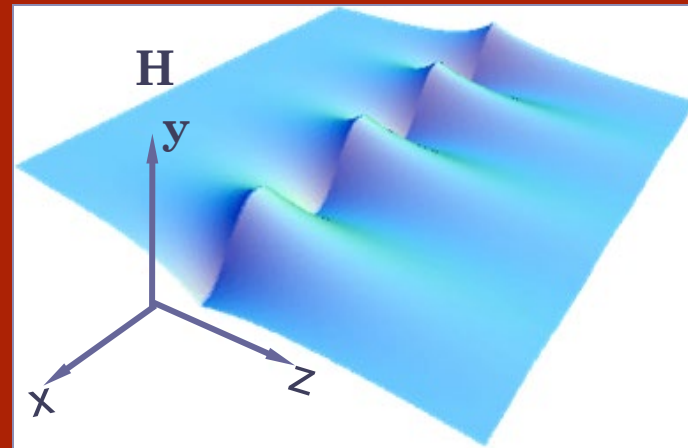
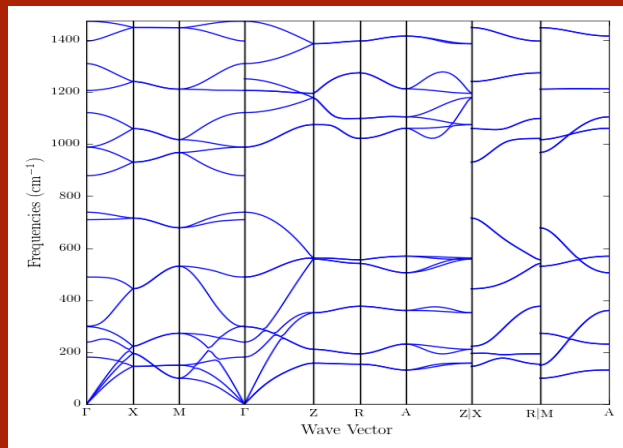


History

- Based on 50 years of metal hydride research
- Patented in 2007
- Patent granted 2018 (after a 10-year security restriction)
- Innovation based on photonic properties of magnesium and manganese hydrides
- Application includes metal doping and shape memory alloys of nickel, titanium and copper
- Applied edge surface and resonance cavity nano-structures included to \uparrow plasma polariton $f(x)$ and reduce ΔH°

How it Works

Photon Dispersion

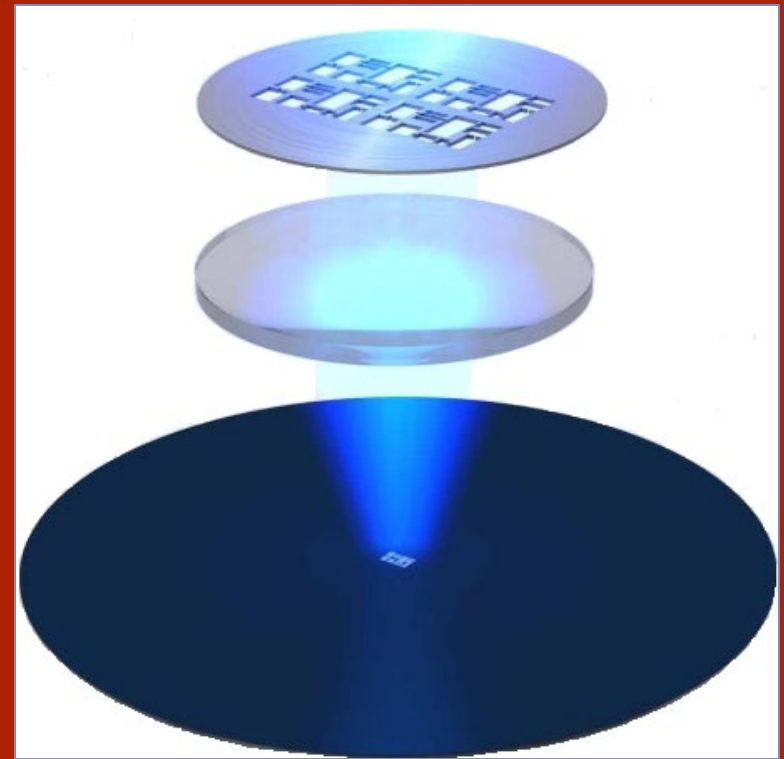


Angstroms thick shape memory alloy layers and metal hydride nanostructures provide a dielectric with black state forming constituents and lower bond energy. Photon absorption and polariton resonance support dissociative amplitude energies when exposed to photonic irradiation.

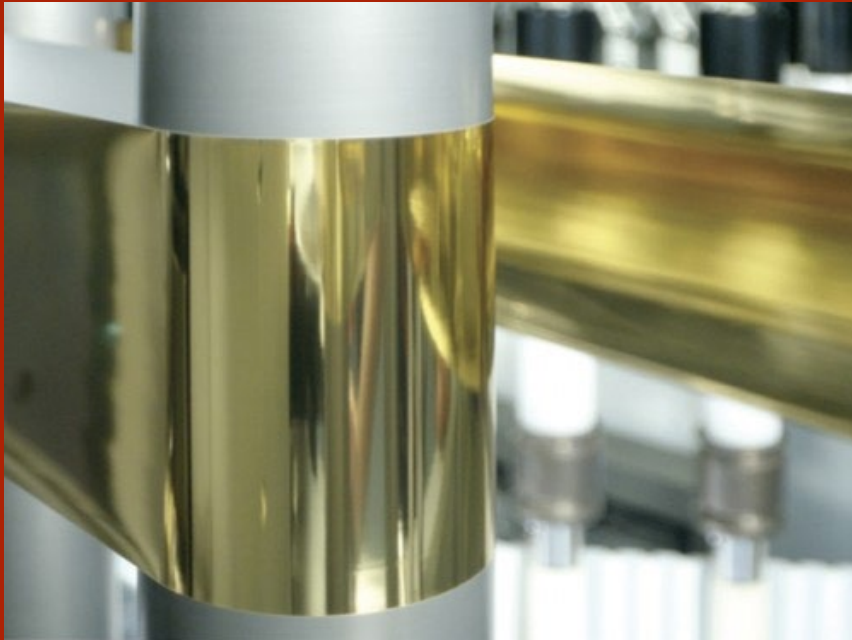
The result is safe, efficient, high-density, photo-reactive, solid-state hydrogen energy storage.

Fabrication

- Uses existing mature fabrication technology
- A lithographic layered nano-structure deposition creates semi-conductive electrical properties
- Thin film reel, compact disc and other substrate format options available depending on application

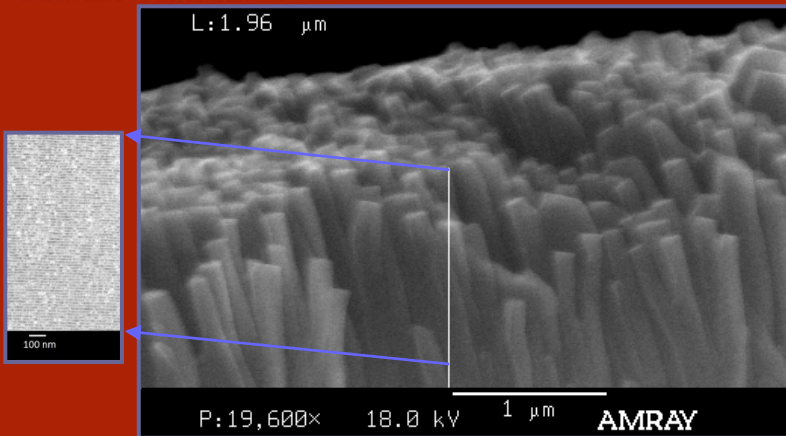


Film Characteristics

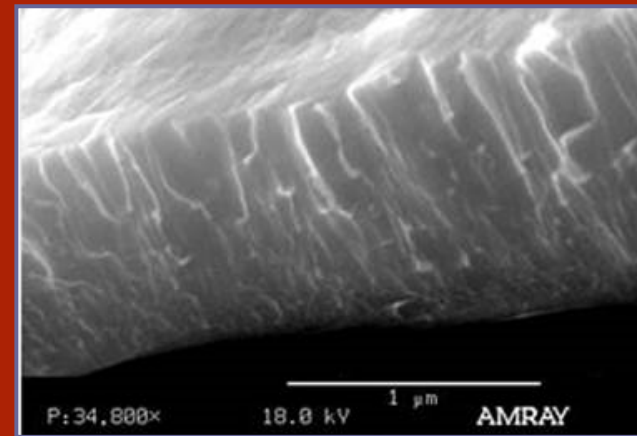


- Film tensile strength 35 kg/cm
- Dielectric strength 8,000 volts
- Resistant to crepitation
- Heat resistant
- UL 94 V-0 non-flammable
- H₂ absorption in 60 seconds
- Rechargeable without pressure
- Rechargeable hundreds of cycles
- 100% recyclable
- Separates Protium and Deuterium
- Deuterium captured during recycle
- No rare-earth elements
- Non-toxic
- Resistant to contamination (can absorb H₂ from incineration or coal fired power plant flue gases)

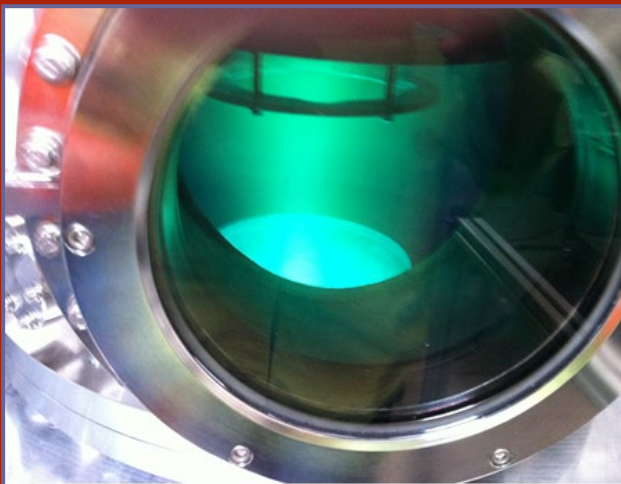
Nano Structuring on Film



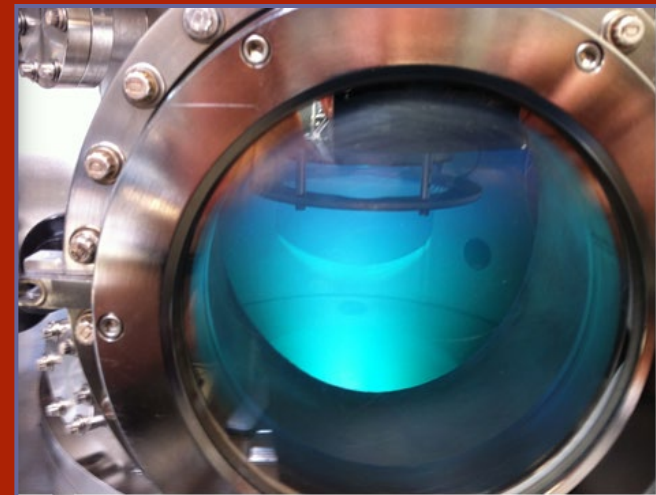
Magnesium (Mg) nano-structured film



Magnesium Hydride (MgH₂) Nano-structured film



Green hue of Magnesium (Mg) deposition

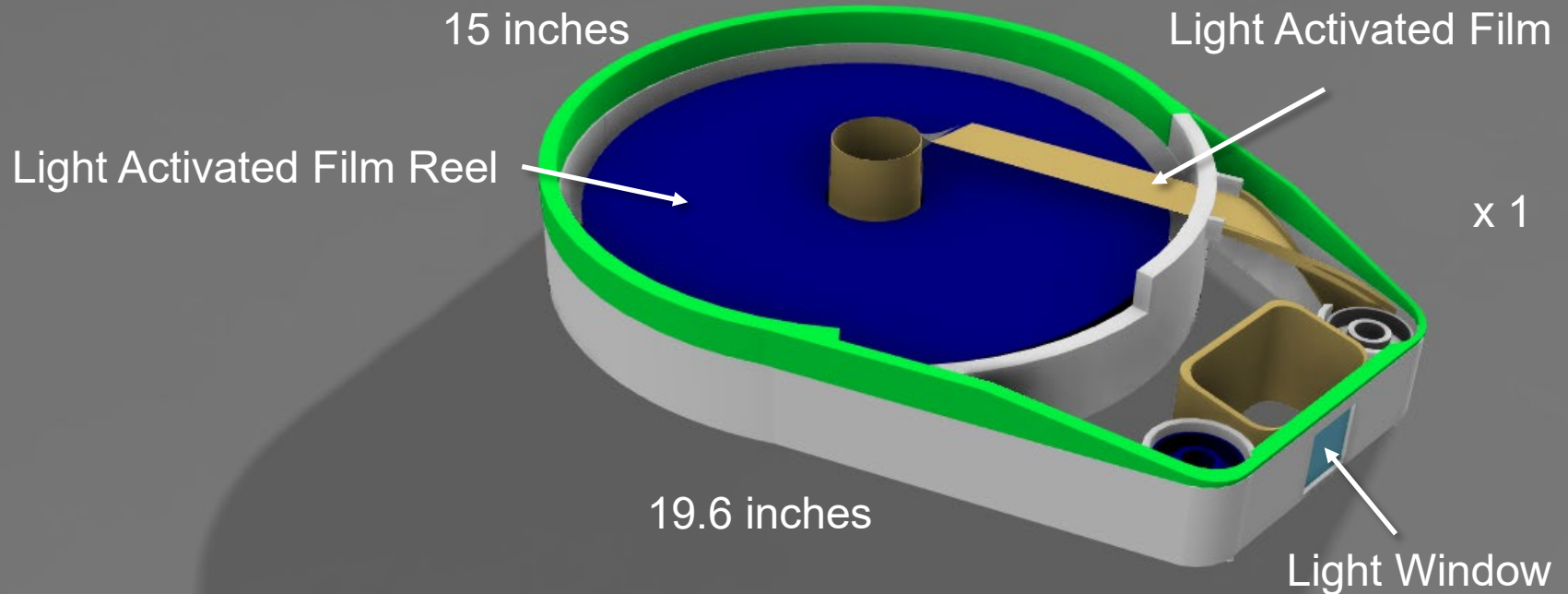


Blue hue of Magnesium Hydride (MgH₂) deposition

Thin Film System (Mobile)

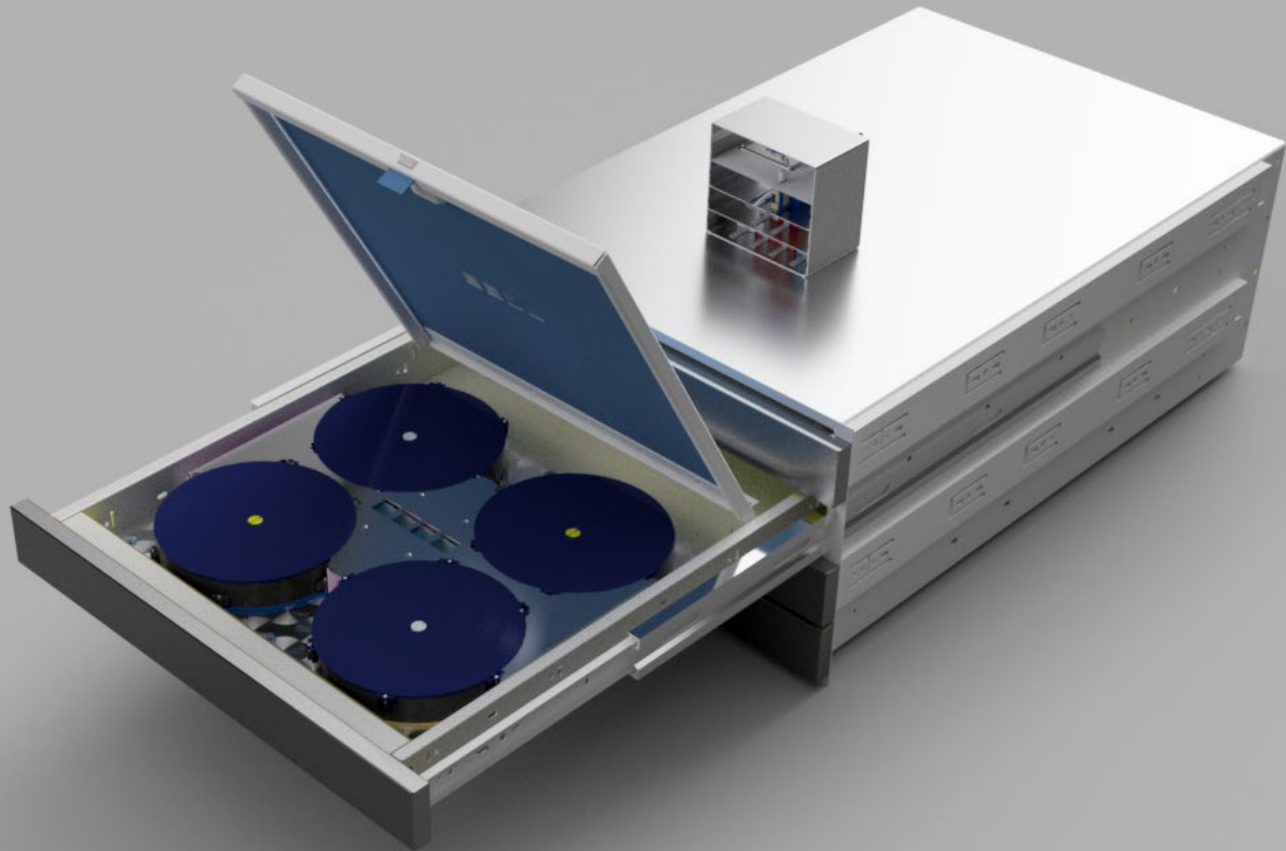


Film System Components



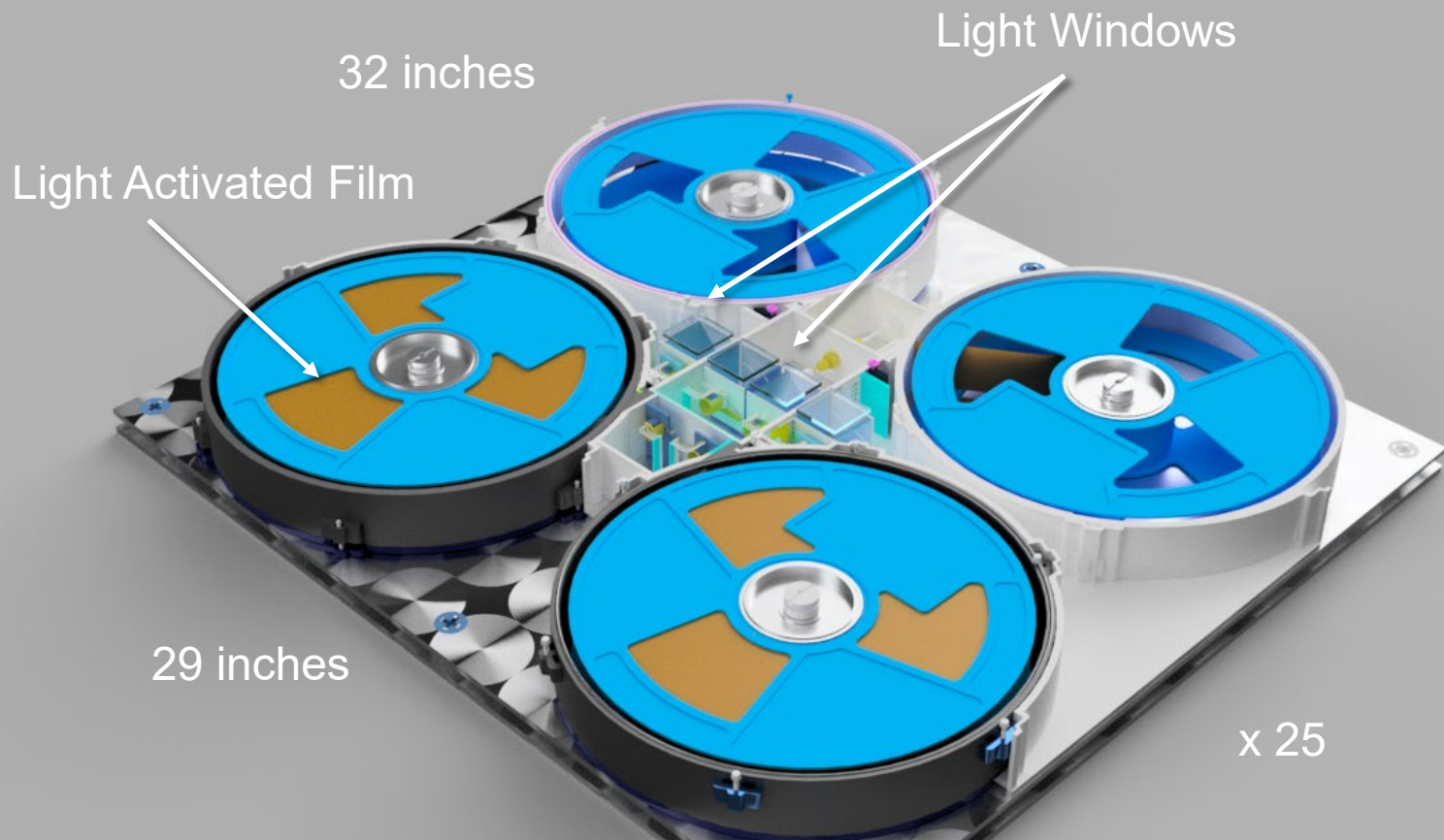
18-pound mobile unit with 252 grams of hydrogen → 5.5 kWh

Thin Film System Stationary

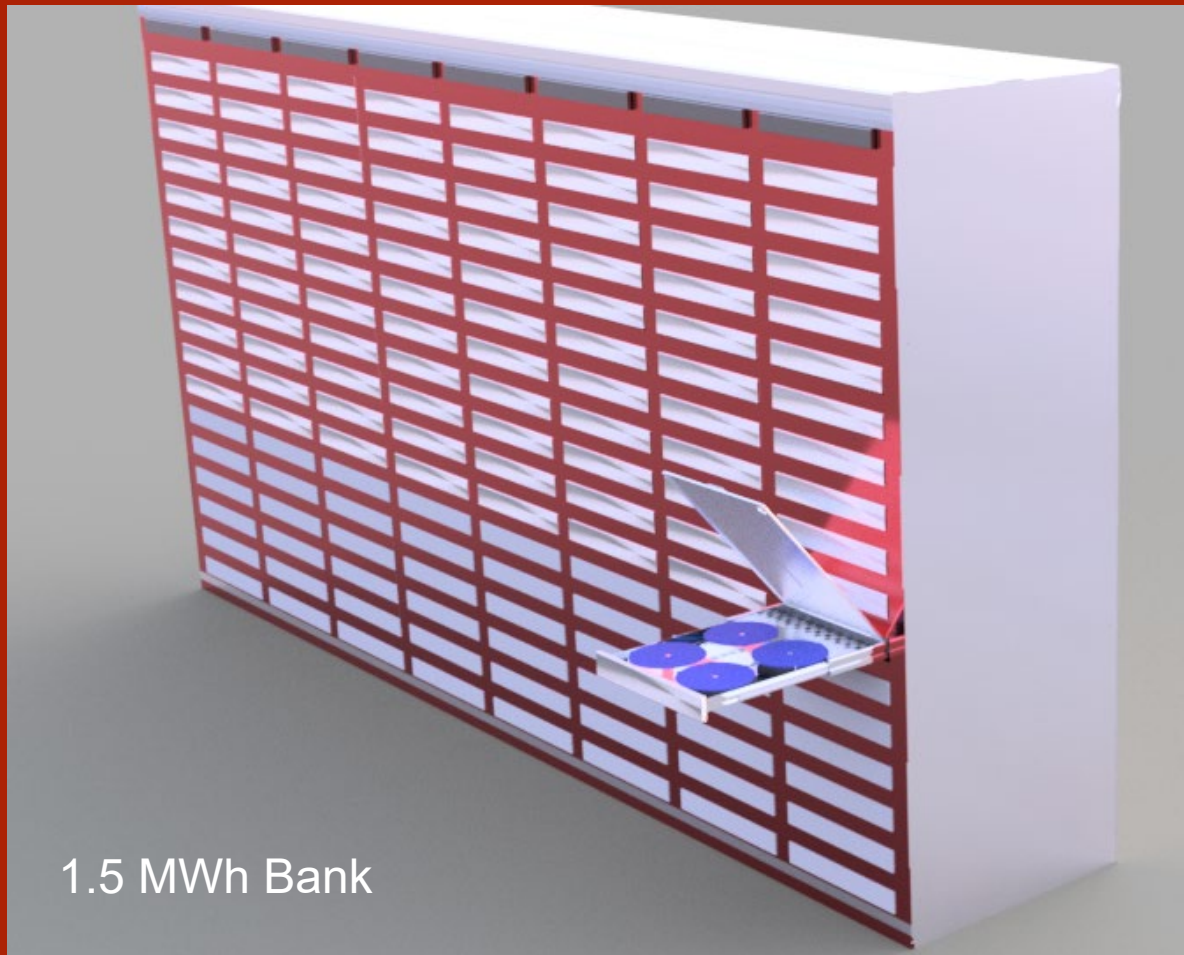


Stationary System Internal

1000-pound stationary unit with 12 kg of hydrogen → 270 kWh

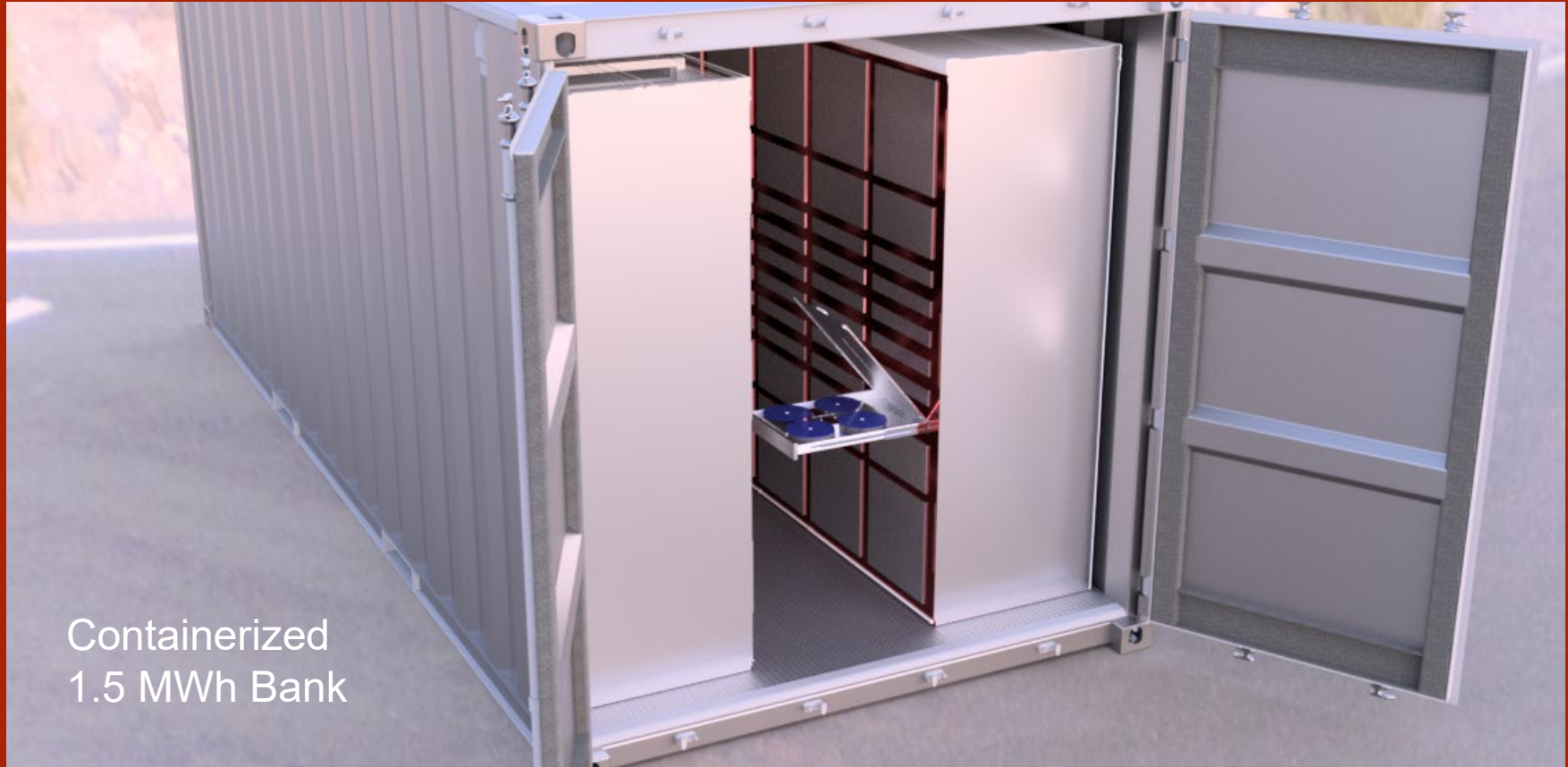


Application (Stationary)



1.5 MWh Bank

Application (Stationary)





Specifications

- Gravimetric energy density
 - Material 6.5 wt% H₂ → 2166 Wh/kg
 - System (mobile) 3.1 wt% H₂ → 1033 Wh/kg
 - Available energy density → 220/670 Wh/kg
- Volumetric energy density
 - Material → 3672 Wh/l
 - System (mobile) → 765 Wh/l
 - Available energy density → 490/515 Wh/l



Unique Solutions

- Reduces green house gases on H₂ absorption
- Requires no energy or pressure to absorb H₂
- Canisters can be charged in 60 seconds on or offsite
- Releases H₂ with less energy than common hydrides and less energy than is required to pressurize hydrogen
- Can commoditize hydrogen from waste-water treatment plants, incineration facilities, smokestacks, industrial flues and fertilizer production
- Requires no expensive distribution infrastructure
- Validated technology is ready and scalable for deployment

Value Proposition

Light activated hydride provides greater value

Batteries	Tanked Hydrogen	Tanked Petroleum Fuels	Diesel Fuel Injection	Unmanned Aircraft	Portable Electronics
200% Longer lasting	1000% lower pressure	5% to 50% lower cost	3% to 12% increased H.P.	Safe fueling and on-board infrastructure	200% Longer lasting
15% to 25% lower cost	15% lower cost	Non-Polluting	10% to 20% better fuel mileage	Electric provides stable platform	25% lower cost
15% to 30% lower weight	15% more efficient	Renewable	90% lower CO 50% lower HC	15% to 30% lower weight	15% to 30% lower weight
100% recyclable	Non-volatile Non-flammable	Non-volatile Non-flammable	Lower exhaust temp Lower noise	200% longer mission duration	Non-toxic and 100% recyclable

- Lighter, Less Pressure than Tanked Hydrogen
- Half the weight and a fraction of the cost of lithium-ion.
- Systems are scalable and can be made small enough to power a cell phone or large enough to power a ship.



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