



Innovative Uses of Nickel

Joint Study Groups' Seminar

*New & Innovative Applications for
Metals*

28 April 2010

Lisbon, Portugal



Innovative Uses of Nickel

Innovative Projects Incorporate
Nickel

- In transportation projects
- In solar power systems
- In offshore platforms



Innovative Uses of Nickel

New and Innovative Products containing Nickel

- In batteries including nickel/zinc and nickel in lithium-ion batteries
- In catalysts including in fuel cells
- In nanotechnologies



Innovative Uses in Transport

Massive Q-Max carriers use nickel containing alloys to transport LNG



Source: Nickel Institute

- Membranes fashioned from nickel-containing alloys
- One is 304L stainless which is 1.2 millimetres thick with a corrugated surface that allows for contraction on contact with the LNG
- The other is a double membrane of 0.7-mm thick nickel-iron Invar® alloy. With 36% nickel and 64% iron, it has an extremely low thermal expansion and contraction rate
- About 700 tonnes of metal are needed for the tanks of a single Q-Max carrier



Solar Energy

Concentrating Solar Power plants generate electricity from the sun's heat use technology which stores the heat in molten salt converting it into energy via steam turbines when it's needed. Nickel containing stainless steels find applications in these projects.



CSP (concentrated solar power) generating electricity

Micro CSP
A solar thermal project in Hawaii, showing tanks for storing the heated liquid





Offshore and Marine Projects



Morecombe Bay Gas Platform

- Nickel-Copper alloys have excellent resistance to seawater corrosion and resist biofouling
- Applications in offshore oil and gas platforms
- New use in offshore wind projects



Nickel Zinc Batteries



- Introduced to the market about one year ago
- Claimed advantages include relatively high energy density, 25 % higher voltage, safety and rapid recharge



Nickel in Lithium-ion Batteries

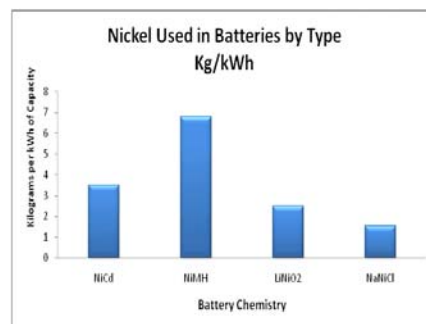
- **Researchers at MIT developed lithium nickel manganese oxide electrodes for a new type of battery that outperforms lithium cobalt oxide (LiCoO₂), the current material of choice**
- **The material could replace batteries used in hybrid cars today and could advance plug-in hybrids**
- **Lithium nickel manganese oxide batteries would be less expensive and more stable than lithium cobalt oxide cells.**
- **The manufacturing process is still expensive**

• *Source: MIT Spectrum spring 2008*



Nickel Use in Lithium-ion Batteries

- **Nissan Motor Co. is working on development of a lithium-ion battery using a lithium nickel manganese cobalt oxide cathode (NMC)**
- **Batteries with Nickel Manganese Cobalt oxide materials can store about twice as much electricity as batteries with positive electrodes made only from manganese**
- **Deployment in electric vehicles in 2015**

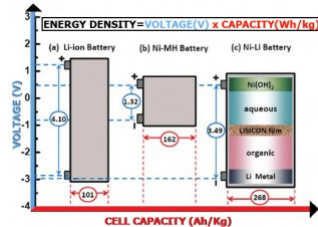


Source: INSG



Nickel Lithium Batteries

- Researchers at Japan's National Institute of Advanced Industrial Science and Technology (AIST) created the first Ni-Li battery
- Combining the best properties of NiMH batteries and Li-ion batteries
- "Ultrahigh" energy density (more than 3.5 times Li-ion batteries) and no risk of catching fire
- Issues to be overcome include slow recharge time and expense to manufacture



Nickel in Catalysts

Activated nickel catalysts are used in

- pharmaceuticals
- food industries
- in fine and industrial chemicals

Products include

- pharmaceutical active substances
- Sweeteners
- Starting materials for polyurethanes for the building materials and automotive sectors



Catalyst in PEM Fuel Cells

- **Proton exchange membrane (PEM) fuel cells generate electricity from hydrogen by chemical reaction with a catalyst promoting the reaction**
- **Researchers at Colorado School of Mines found catalysts of platinum-nickel alloys improve performance of fuel cells by a factor of two over pure platinum**
- **Further improvements are needed to reduce costs to make fuel cells competitive**



Nickel Catalysts

- **Hydrogen fuel cell-powered vehicles may be in commercial use around 2015**
- **A fuel cell vehicle power-train system costs ~ \$8,000 for a 80 kW system, with platinum accounting for 30% of the cost**
- **Nissan managed to reduce the amount of platinum used in a fuel cell vehicle to 50 g in 2008, from 100 g in 2005 but platinum consumption needs to be cut to less than 10 g per vehicle, to bring it in line with conventional gasoline-run vehicles**



Nickel Nanotechnology

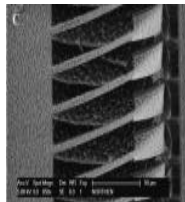


Steven Novack, INL

- Researchers at Idaho National Laboratory use nickel-chromium alloy to transform infrared waves into electricity
- The material is a flexible sheet covered with thousands of microscopically small antennae able to convert infrared waves into electrical energy
- This material can absorb nearly as much energy on a cloudy day as on a clear day
- The material inexpensive to produce (less than existing solar panels) and is said to be 80% efficient vs typical 20% efficiency of conventional solar panels



A Switchable, Gecko-Inspired Adhesive Using Nickel



- Geckos have the ability to cling to rough, smooth, vertical or inverted surfaces. Inspired by this, scientists developed a synthetic, fully reversible, switchable adhesive.
- Adhesion is changed using a magnetic field to actuate nickel cantilevers which are coated with aligned vertical polymeric nanorods.
- When subjected to a magnetic field, the nickel paddles rotate, changing the available surface area of the nanostructures on the paddle surface, modifying adhesion by a factor of 40. This allows the switching of adhesion countless times.
- Further improving this system will lead to a full range of applications



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