

COBALT NEWS

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COMMENT

We are pleased to provide the half year statistics for 2014 in this addition and we see increases in production, most notably from China and also CDI Members such as Ambatovy, Freeport and Umicore. We are pleased to record that Glencore is a Full CDI Member from this year and their tonnage now reports in the Members' section.

Whilst other metals' fortunes have sagged in recent months, it is pleasing to note that the fundamentals for cobalt remain good with buoyant demand for the foreseeable future as indicated by the likes of Roskill and CRU. Cobalt applications in battery technology remain in the ascendant and growth in the aerospace and defence sectors appears strong.

Cobalt is a technology enabling metal and is critical in supporting the global innovation platform and the green agendas being followed by many countries. We have commented frequently about global chemical Regulation and raised our concerns over inappropriate and disproportionate implementation of chemical management regulations. Our industry strongly believes these activities should be based on risk and, should there be a risk identified, then the impact of any attempt to regulate a substance should be fully assessed BEFORE deciding what course of regulatory action should be taken. This element, we are pleased to note, is now better understood and included in the implementation guidance of the REACH Regulation, but much more needs to be done by the Authorities to ensure regulatory efficiency and consistency.

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2014 First Half Production Statistics

Table 1 – CDI First Half 2014 Refined Cobalt Production Statistics (Tonnes)

Member companies	2008	2009	2010	2011	2012	2013	2014
Ambatovy, Madagascar	0	0	0	0	0	1165	1405
BHPB/QNPL, Australia ⁽¹⁾	800	600	1043	1179	1283	1065	0
CTT, Morocco	836	825	729	910	688	780	606
Eramet France	167	198	181	191	167	172	146
Gecamines, DRC ⁽²⁾	130	199	265	360	380	350	250
Glencore ⁽³⁾ :							
Katanga, DRC	0	0	0	0	0	0	1000
Minara, Australia	0	0	0	0	0	0	1400
Mopani, Zambia	0	0	0	0	0	0	0
Nikkelverk, Norway ⁽⁴⁾	1665	1609	1580	1404	1388	1600	1700
ICCI, Canada	1625	1876	1744	1838	1947	1558	1463
Freeport Cobalt, Finland (was OMG)	4310	4177	4157	4880	5345	4690	5284
Rubamin, India (Left CDI 2012) ⁽⁵⁾	0	0	281	295	175	25	0
Sumitomo, Japan	559	507	1041	926	1246	1291	1753
Umicore, Belgium ⁽⁶⁾	1520	1100	1325	1565	2131	2300	2958
Vale, Canada	1068	968	290	1020	1025	1144	937
Zambia ⁽⁷⁾	1546	34	1640	2325	2743	2583	2227
Total	14226	12093	14276	16893	18518	18723	21129

Notes: (1) 2009: BHPB 700mt Jan - Jul and Queensland Nickel Pty (QNPL) 1000mt Aug-Dec. See also Note 12

(2) Estimated prod. Prior to 2012 (3) Glencore joined CDI 2014 (4) Previously reported as Xstrata, Norway (5) Rubamin Joined CDI in 2009 and left in 2013 (6) Includes Umicore's global refined production (7) Chambishi Metals plc Zambia

Production

In Table 1 we show the refined cobalt production from CDI members for the first six months of each calendar year from 2008 to 2014. Glencore are now Full Members of the CDI and so their tonnage re-

ports in Table 1. As a result, direct comparisons of total CDI Member production with the previous year are affected accordingly. As shown in the table, total production from CDI member companies for the first half of 2014 was 21,129 tonnes. The most notable increases in production were from UMICORE, Free-

Table 2 – CDI First Half 2014 Refined Cobalt Availability (Tonnes)

Non-Member companies	2008	2009	2010	2011	2012	2013	2014
China ⁽⁸⁾	9203	8129	17181	17939	15296	17249	20460
India ⁽⁹⁾	448	427	310	360	360	125	100
Kasese, Uganda	331	339	314	327	269	291	0
Katanga, DRC (See Glencore) ⁽¹⁰⁾	120	1083	1776	1298	1071	1000	0
Minara, Australia (See Glencore) ⁽¹⁰⁾	999	1084	1008	945	1110	1400	0
Mopani, Zambia (See Glencore) ⁽¹⁰⁾	710	693	600	600	180	0	0
Norilsk, Russia ⁽¹¹⁾	1161	1157	1241	1205	1147	1224	1173
QNPL, Australia ⁽¹²⁾					0	0	1177
South Africa ⁽¹³⁾	139	120	436	440	494	625	705
Votorantim, Brazil	490	399	655	732	846	796	700
DLA Deliveries	64	93	-8	0	0	0	0
Total	13665	13524	23513	23846	20773	22710	24315

Notes: (8) Excludes Umicore's refined production in China (9) Excludes Rubamin between 2009 and 2013 (10) From 2014 this reports as Glencore in Table 1 (11) Norilsk ceased to be a CDI member in 2009 (12) QNPL ceased to be a CDI Member from 2014 (13) Estimates for RSA May-Jun production 2014

Table 3 – CDI First Half 2014 Total Refined Cobalt Availability (Tonnes)

	2008	2009	2010	2011	2012	2013	2014
CDI Members	14,226	12,093	14,276	16,893	18,518	18,723	21,129
Others	13,665	13,524	23,513	23,846	20,773	22,710	24,315
Total⁽¹⁴⁾	27,891	25,617	37,789	40,739	39,291	41,433	45,444

Notes: 14. Total Supply does not include any estimates for producers not reporting their production

port Cobalt and Sumitomo together with Ambatovy which is currently in ramp-up. Other CDI Members saw modest falls in production for a variety of reasons. As usual, the figure for Umicore includes production from their Ganzhou Hengsheng subsidiary in China.

The Yabulu operations of BHP Billiton were sold to QNPL Pty in July 2009, and QNPL Pty has now ceased to become a CDI Member, so this tonnage now moves into Table 2.

Table 2 summarises refined cobalt production from non-CDI producers together with any deliveries from the DLA stockpile.

As mentioned, refined production attributed to Glencore has now moved into Table 1, so direct comparisons for non-member companies are affected accordingly.

Overall, production from other non-CDI producer companies was 24,315 tonnes with increases across the board, most notably China which has posted an 18.6% increase in refined production compared to the same period in the previous year. We have no further information on any connotative stockpiles of cobalt that might exist in China (see the annual CDI statistics which appeared in the April 2012 edition of the Cobalt News). However, we are aware from general press coverage that metal stockpiles in China are being drawn down. It is emphasised that Chinese production shown in Table 2 does not include Umicore's production in China which is included in Table 1.

The DLA reports its figures slightly differently from the past and the figure shown is the 'change in uncommitted inventory' and should be similar to the old DLA 'delivery' figure we have provided over the years. There have been no sales over the period and therefore the DLA inventory at the end of June 2014 remains at 301 tonnes. It is understood that the DLA cobalt Basic Ordering Agreement sales program has been deactivated until further notice (DLA Strategic Metals news release of March 11, 2011).

The total availability of refined cobalt in the first half of the year from 2008 to 2014 is shown in Table 3. The figures show that overall availability in the first half of 2014 was 45,444 tonnes which is 4,011 tonnes (or ~10%) higher than the same period in 2013, largely as a result of the increase in Chinese refined production. As in the past, we emphasise that the figures do not include production of refined

cobalt from companies treating various cobalt-containing intermediate products and scrap that do not report their figures.

Demand

The CDI has published supply and apparent demand data in the WBMS/CDI "World Cobalt Statistics 2011-2013". The data were derived from worldwide import/export figures. The publication details apparent worldwide refined cobalt demand by geographical location. It can be purchased from either the CDI or WBMS. Please see website 'Publications' for details.

In 2013, apparent worldwide demand totalled around 71,000 tonnes, roughly similar to 2012. As mentioned, the publication can be purchased from either the CDI or the WBMS. See this website for details.

Price

The HG (LMB) price opened 2014 at US\$12.45/lb (compared with US\$11.48/lb for 2012) and at the end of September was US\$14.90/lb which is a little higher than the same time in the previous year. The LG (LMB) price opened at US\$12.35/lb (compared to US\$12.20/lb in 2013) and at the end of September was US\$14.55/lb, one \$/lb higher compared to the year before. The 2014 annual average HG price to end September is US\$14.52/lb and for LG it is US\$14.22/lb (the CDI takes the average bid/offer spread for both the HG and LG Metal Bulletin price quotation when calculating its average price).

Cobalt has traded on the LME since February 2010 with the 3M contract which was joined by cash trading in May of that year. The average LME cash price for 2014 to end September is US\$13.81/lb (the CDI takes the average daily bid/offer cash spread for cobalt and averages this over the period). The C-3 spread varied between a US\$525/tonne contango and a US\$500/tonne backwardation with an average spread for period in backwardation of about US\$19/tonne.

Stanford researchers seek 'Holy Grail' in battery design

Pure lithium anode closer to reality with development of protective layer of interconnected carbon domes

Engineers across the globe have been racing to design smaller, cheaper and more efficient rechargeable batteries to meet the power storage needs of everything from handheld gadgets to electric cars.

In a paper published in the journal *Nature Nanotechnology*, researchers at Stanford University report that they have taken a big step toward accomplishing what battery designers have been trying to do for decades – design a pure lithium anode.

All batteries have three basic components: an electrolyte to provide electrons, an anode to discharge those electrons, and a cathode to receive them.

Today, we say we have lithium batteries, but that is only partly true. What we have are lithium ion batteries. The lithium is in the electrolyte, but not in the anode. An anode of pure lithium would be a huge boost to battery efficiency.

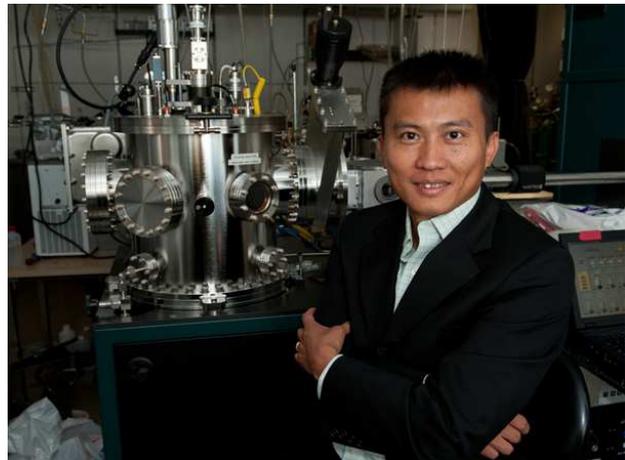
"Of all the materials that one might use in an anode, lithium has the greatest potential. Some call it the Holy Grail," said Yi Cui, a Stanford professor of materials science and engineering and leader of the research team. "It is very lightweight and it has the highest energy density. You get more power per volume and weight, leading to lighter, smaller batteries with more power."

But engineers have long tried and failed to reach this Holy Grail.

"Lithium has major challenges that have made its use in anodes difficult," said Guangyuan Zheng, a doctoral candidate in Cui's lab and first author of the paper. "Many engineers had given up the search, but we found a way to protect the lithium from the problems that have plagued it for so long."

In addition to Cui and Zheng, the research team includes Steven Chu, the former U.S. secretary of energy and Nobel laureate who recently resumed his professorship at Stanford.

"In practical terms, if we can triple the energy density and simultaneously decrease the cost four-fold, that would be very exciting," Chu said. "We would have a cell phone with triple the battery life and an electric vehicle with a 300-mile range that cost \$25,000 –



Yi Cui, Stanford professor of materials science and engineering, and his team are designing a pure lithium anode for rechargeable batteries.

and with better performance than an internal combustion engine car getting 40 mpg."

The engineering challenge

In the paper, the authors explain how they are overcoming the problems posed by lithium.

Most lithium ion batteries, like those in a smart phone or hybrid car, work similarly. The key components include an anode, the negative pole from which electrons flow out and into a power-hungry device, and the cathode, where the electrons re-enter the battery once they have traveled through the circuit. Separating them is an electrolyte, a solid or liquid loaded with positively charged lithium ions that travel between the anode and cathode.

During charging, the positively charged lithium ions in the electrolyte are attracted to the negatively charged anode and the lithium accumulates on the anode. Today, the anode in a lithium ion battery is actually made of graphite or silicon.

Engineers would like to use lithium for the



Steven Chu

anode, but so far they have been unable to do so. That's because the lithium ions expand as they gather on the anode during charging.

All anode materials, including graphite and silicon, expand somewhat during charging, but not like lithium. Researchers say that lithium's expansion during charging is "virtually infinite" relative to the other materials. Its expansion is also uneven, causing pits and cracks to form in the outer surface, like paint on the exterior of a balloon that is being inflated.

The resulting fissures on the surface of the anode allow the precious lithium ions to escape, forming hair-like or mossy growths, called dendrites. Dendrites, in turn, short-circuit the battery and shorten its life.

Preventing this build up is the first challenge of using lithium for the battery's anode.

The second engineering challenge involves finding a way to deal with the fact that lithium anodes are highly chemically reactive with the electrolyte. It uses up the electrolyte and reduces battery life.

An additional problem is that the anode and electrolyte produce heat when they come into contact. Lithium batteries, including those in use today, can overheat to the point of fire, or even explosion. They are, therefore, a serious safety concern. The recent battery fires in Tesla cars and on Boeing's Dreamliner jet plane are prominent examples of the challenges of lithium ion batteries.

To solve these problems the Stanford researchers built a protective layer of interconnected carbon domes on top of their lithium anode. This layer is what the team has called nanospheres.

The Stanford team's nanosphere layer resembles a honeycomb: it creates a flexible, uniform and non-reactive film that protects the unstable lithium from the drawbacks that have made it such a challenge. The carbon nanosphere wall is just 20 nanometers thick. It would take 5,000 layers stacked one atop another to equal the width of a single human hair.

"The ideal protective layer for a lithium metal anode needs to be chemically stable to protect against the chemical reactions with the electrolyte and mechanically strong to withstand the expansion of the lithium during charge," said Cui, who is a member of the Stanford Institute for Materials and Energy Sciences at SLAC National Accelerator Laboratory.

The Stanford nanosphere layer is just that. It is made of amorphous carbon, which is chemically stable, yet strong and flexible so as to move freely up and down with the lithium as it expands and contracts during the battery's normal charge-discharge cycle.

Ideal within reach

In technical terms, the nanospheres improve the coulombic efficiency of the battery – a ratio of the amount of lithium that can be extracted from the anode when the battery is in use compared to the amount put in during charging. A single round of this give-and-take process is called a cycle.

Generally, to be commercially viable, a battery must have a coulombic efficiency of 99.9 percent or more, ideally over as many cycles as possible. Previous anodes of unprotected lithium metal achieved approximately 96 percent efficiency, which dropped to less than 50 percent in just 100 cycles – not nearly good enough. The Stanford team's new lithium metal anode achieves 99 percent efficiency even at 150 cycles.

"The difference between 99 percent and 96 percent, in battery terms, is *huge*," Cui said. "So, while we're not quite to that 99.9 percent threshold where we need to be, we're close and this is a significant improvement over any previous design. With some additional engineering and new electrolytes, we believe we can realize a practical and stable lithium metal anode that could power the next generation of rechargeable batteries."

This article was written by Andrew Myers and first published in Stanford News <http://news.stanford.edu/news/2014/july/pure-lithium-battery-072914.html>

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Applied Materials Adds Cobalt to Chips for “Significant Materials Change”

In recent months, most of the buzz about cobalt in the technology space has centered on how the metal will play into Tesla Motors’ (NASDAQ:TSLA) decision to build a \$5-billion lithium-ion battery “gigafactory” in the Southwest United States.

Yesterday, however, Applied Materials (NASDAQ:AMAT), a company that provides equipment, services and software used for manufacturing semiconductors, made a splash of its own by debuting the Applied Endura® Volta™ CVD Cobalt system, which it says is “the only tool capable of encapsulating copper interconnects in logic chips beyond the 28nm node.”

A little background

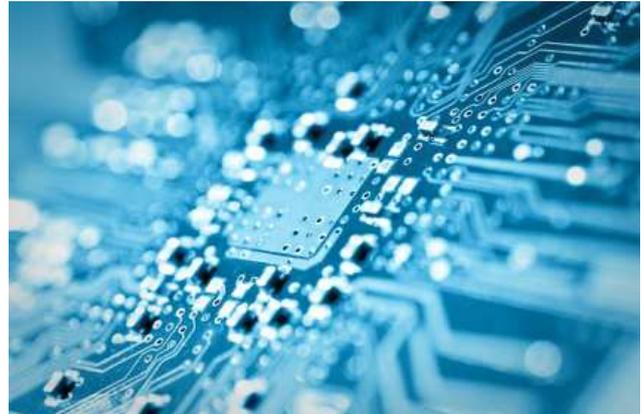
Understanding just what that statement means requires a little background information. Fortunately, Don Clark, writing for The Wall Street Journal’s Digits, offers a good explanation.

Clark notes that essentially Applied Materials has developed a way to fix “defects” that are creating difficulties for chip manufacturers. The main issue is that as those manufacturers decrease the size of transistors, which “act as tiny switches on the chips,” the copper wires that connect the transistors malfunction. Specifically, “[l]ike a large volume of water forced into a smaller streambed, current moves faster and causes impacts akin to the rocks or boulders moved by a rushing torrent.” In the process, copper atoms are sometimes shaken loose, with chips ceasing to work as a result.

The solution

One solution, of course, would be to stop decreasing the size of transistors. However, Dr. Randhir Thakur, executive vice president and general manager of the Silicon Systems Group at Applied Materials, yesterday cited Moore’s Law as a reason it’s unrealistic to expect that to happen. Created by Intel (NASDAQ:INTC) co-founder Gordon Moore, the law states that the number of transistors on a chip will double about every two years.

Luckily, Applied Materials has come up with another answer to the problem: envelop the copper wires in cobalt. Interestingly, as EE Times’ R. Colin Johnson explains, that’s not a new idea; in fact, “other barrier materials have been proposed” in the past. What makes Applied Materials’ approach unique is the process it has developed to apply the cobalt.



That process is comprised of two steps that together make up the Endura® Volta™ CVD system. The first involves depositing a “thin, conformal CVD cobalt liner to increase the gap fill window of copper in narrow interconnects,” while the company describes the second as a “cobalt capping step” that completes the encasement of the copper wires.

The result, Applied Materials states, is more than an 80-fold improvement in chip reliability. However, beyond that, the inclusion of cobalt in chips is significant because it’s quite rare for the materials used to create them to be changed. Indeed, according to Applied Materials, “[t]he introduction of cobalt as a superior metal encapsulation film marks the most significant materials change to the interconnect in over 15 years.”

Moving forward

Often the excitement of new technological developments is tempered by uncertainty regarding commercial viability, but Applied Materials has made some progress in that department — Clark notes that the company has already sent 75 Endura® Volta™ CVD units out to customers for testing. That said, there’s no guarantee the process will be taken up. “The machines aren’t likely to be introduced in large volumes until manufacturers are ready ... to create smaller transistors,” according to Clark.

For now, Applied Materials is happy just to see them gain some traction. “It is deeply satisfying that these materials and process innovations in development for almost a decade are now being adopted by our customers for their high-performance mobile and server chips,” Dr. Sundar Ramamurthy, vice president and general manager of Metal Deposition Products at the company, is quoted as saying in the company’s press release.

This article was written by Charlotte McLeod and was first published in Cobalt Investing News <http://cobaltinvestingnews.com/3671-applied-materials-cobalt-chips-tantalum/>

Controlling ferromagnetic domains using light

A variety of magnetic materials can be controlled using only polarized light, according to new work carried out by an international team of researchers. The unexpected and so far unexplained discovery shows that the optical phenomenon, which was previously thought to be possible only in ferrimagnets, is actually much more general. The discovery could potentially have a major impact on data storage, as it could allow magnetic bits to be rapidly switched by optical pulses in state-of-the-art hard drives.

From magnetic tapes to computer hard drives, rewritable data storage has traditionally been achieved using ordering of magnetic domains. Individual bits are stored by setting the magnetization vector of a particular domain to point either up or down. However, as data processing becomes faster in modern computers, data storage needs to speed up too. This presents both practical and theoretical difficulties for magnetic data storage. The traditional way to flip a bit is to apply a magnetic field. However, speedily setting magnetic domains requires stronger and faster pulsed magnetic fields, and these are difficult to generate in a computer's hard drive. Furthermore, in 2004 researchers using magnetic fields generated by the Stanford Linear Accelerator showed that the extreme fields needed to switch a domain in less than two picoseconds caused a complete breakdown of the magnetic order of a material, apparently placing an ultimate speed limit on magnetic data storage.

Speedy switching

In 2006 Theo Rasing and colleagues at Radboud University Nijmegen in the Netherlands showed that the magnetization of domains in ferrimagnets – materials that contain two types of magnetic domain oriented in opposite directions – can be controlled by circularly polarized light. This control could be accomplished by a low-power laser pulse with a duration as short as 40 femtoseconds. But while the rare-Earth ferrimagnets used by Rasing and subsequent researchers were popular in magneto-optical drives, they are not used in computer hard drives because they are easily magnetized and demagnetized. The magnetism of very small domains is therefore quite unstable, thus limiting the density at which the materials can store data.

But now, Stéphane Mangin of the University of Lorraine in France, along with colleagues in the US, Germany and Japan, has demonstrated that this type of optical switching can also be achieved in ferromagnetic films made from materials such as cobalt, platinum, nickel and palladium. These materials are of great interest to hard-drive

developers but until now most of the theories explaining optical switching were applicable only to ferrimagnets. "Here we are really showing that is not the case – you can have different kinds of ferromagnetic or other magnetic materials that show this behaviour," says Mangin, but cautions that they still do not know how this occurs.

The researchers tested a selection of ferromagnetic films, varying parameters such as the relative thicknesses, the proportions of different materials and the number of layers, to confirm their finding. Using a standard method, the team viewed each sample under a Faraday microscope, which uses polarized light. A domain polarized in one direction appears black, whereas a domain polarized in the other appears white. The researchers irradiated the samples using 100 femtosecond laser pulses and found that they were able to switch domains as well as introduce polarization to parts with no net polarization.

Frazzled physicists

Both Rasing and Bert Koopmans, a nanomagnetism expert at the Technical University of Eindhoven in the Netherlands, were taken aback. "It gives me a kind of rollercoaster feeling," says Koopmans. "The interpretation of these [optical-switching] experiments has changed throughout the years. I thought that I understood everything and this experiment has completely frazzled my mind." Both researchers, however, insist that more needs to be done to demonstrate that the work can be useful in hard drives. "In this paper, there are no results from single pulses – only from accumulated pulses," says Rasing. "So, it is a bit difficult to tell whether it is really very fast optical switching or heating by the laser – although the helicity is clearly important here – that has been demonstrated." Mangin and his collaborators are currently working on both a theoretical explanation and practical development of the technique.

The research is published in *Science*.

This article was written by Tim Wogan, a science writer based in the UK and was first published in Physics World, <http://physicsworld.com/cws/article/news/2014/aug/21/controlling-ferromagnetic-domains-using-light>

New material steals oxygen from air



Professor Christine McKenzie (center in photo) and postdoc Jonas Sundberg, Department of Physics, Chemistry and Pharmacy at the University of Southern Denmark have synthesized a material that absorb oxygen in large quantities and store it. *Credit: Image courtesy of University of Southern Denmark*

Researchers from the University of Southern Denmark have synthesized crystalline materials that can bind and store oxygen in high concentrations. The stored oxygen can be released again when and where it is needed.

We do fine with the 21 per cent oxygen in the air around us. But sometimes we need oxygen in higher concentrations; for example lung patients must carry heavy oxygen tanks, cars using fuel cells need a regulated oxygen supply. Perhaps one day in the future even sunlight-driven "reversible" fuel cells will be made. With these we will have to separate oxygen from hydrogen in order to recombine them in order to get energy.

Now Professor Christine McKenzie (center in photo) and postdoc Jonas Sundberg, Department of Physics, Chemistry and Pharmacy at the University of Southern Denmark have synthesized a material that absorb oxygen in large quantities and store it.

"In the lab, we saw how this material took up oxygen from the air around us," says Christine McKenzie.

The new material is crystalline, and using X-ray diffraction the researchers have studied the arrangement of atoms inside the material when it was filled with oxygen, and when it was emptied of oxygen.

Oxygen comes and goes in many places

The fact that a substance can react with oxygen is not surprising. Lots of substances do this -- and the

result is not always desirable: Food can go rancid when exposed to oxygen. On the other hand a wine's taste and aroma is changed subtly when we aerate it -- but not with too much oxygen! Our bodies cannot function if we do not breathe.

"An important aspect of this new material is that it does not react irreversibly with oxygen -- even though it absorbs oxygen in a so-called selective chemisorptive process. The material is both a sensor, and a container for oxygen -- we can use it to bind, store and transport oxygen -- like a solid artificial hemoglobin," says Christine McKenzie.

A bucket full (10 litres) of the material is enough to suck up all the oxygen in a room.

"It is also interesting that the material can absorb and release oxygen many times without losing the ability. It is like dipping a sponge in water, squeezing the water out of it and repeating the process over and over again," Christine McKenzie explains.

Once the oxygen has been absorbed you can keep it stored in the material until you want to release it. The oxygen can be released by gently heating the material or subjecting it to low oxygen pressures.

Heat and pressure releases the stored oxygen

"We see release of oxygen when we heat up the material, and we have also seen it when we apply vacuum. We are now wondering if light can also be used as a trigger for the material to release oxygen -- this has prospects in the growing field of artificial photosynthesis," says Christine McKenzie.

The key component of the new material is the element cobalt, which is bound in a specially designed organic molecule.

"Cobalt gives the new material precisely the molecular and electronic structure that enables it to absorb oxygen from its surroundings. This mechanism is well known from all breathing creatures on earth: Humans and many other species use iron, while other animals, like crabs and spiders, use copper. Small amounts of metals are essential for the absorption of oxygen, so actually it is not entirely surprising to see this effect in our new material," explains Christine McKenzie.

Depending on the atmospheric oxygen content, temperature, pressure, etc. it takes seconds, minutes, hours or days for the substance to absorb oxygen from its surroundings. Different versions of the substance can bind oxygen at different speeds. With this complexity it becomes possible to produce devices that release and/or absorb oxygen under different circumstances -- for example a mask containing layers of these materials in the correct sequence might actively supply a person with oxygen directly from the air without the help of pumps or high pressure equipment.

"When the material is saturated with oxygen, it can be compared to an oxygen tank containing pure oxygen under pressure -- the difference is that this material can hold three times as much oxygen," says Christine McKenzie.

"This could be valuable for lung patients who today must carry heavy oxygen tanks with them. But also divers may one day be able to leave the oxygen tanks at home and instead get oxygen from this material as it "filters" and concentrates oxygen from surrounding air or water. A few grains contain enough oxygen for one breath, and as the material can absorb oxygen from the water around the diver and supply the diver with it, the diver will not need to bring more than these few grains."

The material has been designed and synthesized at University of Southern Denmark. Some of the gas uptake measurements have been made with special equipment by colleagues at the University of Sydney, Australia.

The above story was first published in Science Daily (<http://www.sciencedaily.com/releases/2014/09/140930113254.htm>) and is based on materials provided by University of Southern Denmark. Note: Materials may be edited for content and length.

Journal Reference:

1. Jonas Sundberg, Lisa J. Cameron, Peter D. Southon, Cameron J. Kepert, Christine J. McKenzie. **Oxygen chemisorption/desorption in a reversible single-crystal-to-single-crystal transformation.** *Chemical Science*, 2014; 5 (10): 4017 DOI: [10.1039/C4SC01636J](https://doi.org/10.1039/C4SC01636J)

***THE* Cobalt Conference**

**Toronto Hilton
20/21 May 2015**

The Cobalt Development Institute will hold its annual Cobalt Conference in Toronto, Canada in May 2015.

The programme will include:

- Detailed cobalt market reviews
- Review of global cobalt trade flows
- Regulatory matters and updates
- Supply chain sustainability
- Presentations on major cobalt related projects and mining operations
- Latest on sector developments and applications such as GTL, Superalloys, Batteries, Chemicals

If you have a paper which you feel would be of interest, there is still time to include it in the programme. Please contact David Weight at the CDI.