Green Indicator

In this issue a burning topic is reviewed: the impact of renewable energy technologies with respect to rare-earth metals. The topic is a serious issue and will have to be addressed in the pursuit of truly renewable production of energy, including a responsible way of mining and purifying these types of meals; the example of neodymium is used, but several other metals in this group has similar issues in other applications. We will also widen our perspectives with respect to catalysis with the antagonistic catalysis concept.

/ Christian Hulteberg

Is neodymium a limit to renewable energy?

Not only fossil resources such as coal, oil and gas are limited in supply on our planet. Metals are also limited and over the last year the reserves of the rare earth metal neodymium has been discussed as a possible barrier for the large scale introduction of renewable energy and technology such as electric vehicles. As neodymium may not be the most well-known element, a short introduction to its properties and use is given below.

Neodymium is used to produce the strongest permanent magnets known, several times stronger than ordinary ferrite magnets. This property makes it possible to use neodymium magnets much smaller than ordinary magnets could have been. The neodymium magnets are used in a wide variety of application where size and weight are important parameters, such as micro-electronics. What is of higher interest is however the use of neodymium magnets in electric motors and generators.

Hybrid and electric vehicles are an important part of the answer as to how we are to reduce the use of fossil oil. An important part of the electric motor in such vehicles is the magnets which preferable should be small and light in weight. An electric vehicle may require several kgs of neodymium for its motor. Wind turbine generators are another important application for neodymium magnets. As the power generation capacity of wind turbine increases, size and weight become more important. New wind turbines can therefore contain several hundred kgs of neodymium – per MW capacity. An ordinary sized wind turbine may thus require two metric tons of the rare metal.

As other rare earth metals, neodymium is not very rare in the earth crust, but the concentrations are low. The metal is thus mostly mined as a byproduct to other metals, such as iron or uranium. It was previously produced in large scale in the Mountain Pass mine in California, USA, but due to severe environmental impact including radioactive waste water, the mine was closed. Today, about 90% of the worlds production, which is annually less than 20 000 metric tons, comes from China. Demand is expected to be doubled in just a few years and recent signals from China are that exports of the metal will decrease. Other areas are being prospected for mining but most are still several years away from production. Today electric vehicles are being introduced to the market by several producers and wind power is increasing rapidly, all depending on neodymium magnets. Will the real breakthrough for these technologies come to a halt because of lack of neodymium? According to some experts, the risk is real.

Green Indicator #19, March 2012

CatScan

Antagonistic catalysis

Does your reaction work with both acid and base catalysts? Or do you think that a combination of the two functionalities would be perfect for your process, but that these functionalities cannot be combined? Then it may be time to reconsider, in a recent paper (Angew. Chem. Int. Ed. 50 (2011) 9615) researchers have achieved just this: combining both acid and base functionalities on the same surface.

The scholars managed to create a bifunctional, enzyme-mimicking surface similar to a traditional heterogeneous catalyst but with multiple functionality. They then used this surface for performing tandem reactions. The group managed to show, using e.g. synchrotron light, that it was feasible to keep the two functionalities on the surface without neutralizing each other, which will potentially decrease energy consumption used in separation and purification of intermediates.

The relationship between the acidic and basic functionalities may be varied by changing the ratio of polyacid and amine groups on the catalyst surface. Several polyacids were investigated and the flexibility with respect to this will open up several interesting fields where this type of catalyst may be used in the future.

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