Capitol conjecture
The impact of Washington’s new policies and stimulus package, plus new materials recommendations for the DOE
feature articles

Daytona Beach ICACC report ................................................................. 18

Capitol Conjecture
Jennifer Sowash
- A look at Washington’s new stimulus package and possible Fiscal Year 2009 funding ........................................ 22
- Chart of science funding in the American Recovery and Reinvestment Act ........................................ 23
- Nation’s top scientists call for new wave of energy-related materials research ........................................ 26

NSF recognizes three assistant professors with 2009 CAREER awards in ceramics ......................................................... 30

Planning ahead for PACRIM8 ................................................................. 35
Themes and schedule-at-a-glance available, plus Vancouver’s inviting culture.

Improved oxidation resistance of high-carbon-containing castables via antioxidant blend ........................................ 40
A.P. Luz, F.A.O. Valenzuela, V.G. Domiciano, M.A.M. Brito and V.C. Pandofelli

departments

News & Trends ....................................................................................... 3
- NIST wants to fund your research project
- Meet the President’s Council of Student Advisors

ACerS Spotlight .................................................................................... 9
- ’Gap’ coverage for unemployed members
- Knowledge initiative announced
- ACerS 2009 short courses schedule

People in the Spotlight .......................................................................... 12

Ceramics in Energy ................................................................................ 13
- Making fuel cells more affordable
- Coating impedes degradation of SOFCs

Ceramics in the Environment ................................................................. 15
- Green energy from greenhouse gases

Advances in Nanomaterials .................................................................... 16
- Yale ‘shapes up’ nanomanufacturing with bulk metallic glass molds
- Silica particles give cavities the slip

Research Briefs ....................................................................................... 51
- NIST’s ‘verdict’ may double concrete’s lifespan
- Lab-grown diamonds prove bigger and better

cover story

Capitol Conjecture
The impact of Washington’s new policies and stimulus package, plus new materials recommendations for the DOE - page 18

Ceramics in the Environment
Green energy from greenhouse gases - page 15

Advances in Nanomaterials
Silica nanoparticles give cavities the slip - page 17
Green energy from greenhouse gases

Abdul-Majeed Azad, University of Toledo

The ultimate chemical fate of conventional fossil fuel combustion is always carbon dioxide and water – CO₂ and H₂O – two well-known greenhouse gases that are major contributors to global warming.

In 2007, for instance, the global level of CO₂ was 30 billion metric tons, and this level is expected to increase to 43 billion metric tons by 2030. The United States, unfortunately, is the largest contributor to these CO₂ levels, accounting for 22.2 percent of global CO₂ emissions.

What if we could convert CO₂ into carbon monoxide (CO), water into hydrogen-gas (H₂) and a mixture of CO₂+H₂O – the ultimate product of complete combustion of hydrocarbon-based fossil fuels, including biofuels – into syngas (CO+H₂)?

Syngas is a valuable precursor to the well-known Fischer–Tropsch process, used by the Germans during WW II to make synthetic fuels. All these streams (CO, H₂ and CO + H₂) are also ideal fuels for solid oxide fuel cells.

Hence, the waste products of combustion essentially could become a fuel source and could be recycled. Alternatively, if desired, CO could be converted to H₂ via a catalytic water-gas-shift reaction that, then, could become feed for proton exchange membrane fuel cells.

At the University of Toledo, we have developed an inexpensive heterogeneous ceramic catalyst we’ve found is capable of converting CO₂ and H₂O into CO and H₂, respectively, on a 1:1 molar basis, under mild temperature and atmospheric pressure.

When fed into an intermediate-temperature SOFC at 650°C, these streams create an open circuit voltage, quite comparable with that of the same SOFC run with pure H₂.

It is predicted that global clean energy markets are going to quadruple in the next decade from $55.4 billion in revenue in 2006 to more than $226.5 billion by 2016. The approximate market size of this greenhouse gas mitigation is more than $1 billion.

The technology and product described have the potential to offer a solution that would benefit a wide range of stakeholders, from energy producers and suppliers to SOFC manufacturers, organic synthesis firms, consumers and more.

The technology is also of relevance to NASA’s in-situ resource utilization program for Mars exploration, because Martian atmosphere is approximately 96 percent CO₂. NASA might be interested in looking at the UT technology for creating CO from Martian CO₂ and, use it either as such or after water-gas-shift reaction to generate hydrogen as fuel for a SOFC stack. In the Martian context, to make the process truly self-sustained, one could use solar concentrators to generate enough heat to raise the temperature to cause the desired conversion. Thus, the fuel can be generated and used during daytime and stored and used to run fuel cells during the night hours.

The Department of Defense uses logistic fuels for its operations and could employ the greenhouse gas-fueled SOFC technology for many military field operations, including mobile forward base units, auxiliary field hospitals, field command posts, operational forays and unmanned aerial vehicles. NASA is also currently looking at non-petroleum-based jet fuels in the pursuit of alternatives that can power commercial jets, and a greenhouse gas-derived F-T fuel could respond to that quest. (Visit: http://utoledo.edu/)