

Materials research and the ‘energy crisis’



Forget about ‘*the*’ solution. Instead, we need to work toward a strong, sustainable mosaic of many solutions.

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I will try to outline my credo for why and how, from the basic science point of view, we should tackle energy-related materials research issues.

In the title, I put energy crisis in inverted commas. Why? Because for at least the next few hundred years, we do not lack a relatively cheap source of energy – we have coal (and coal liquefaction and gasification are known processes).

Unfortunately, because most coal is rather dirty, this leads to assured environmental and highly likely climate problems. Even those that doubt the latter cannot ignore the former. Visit some of the world’s emerging industrial areas and you can quote from the 1960s Tom Lehrer song *Pollution*, “Don’t drink the water and don’t breathe the air,” and add in land pollution, although it does not rhyme. Thus, we find the true driving forces for weaning us off fossil fuels and for developing alternative, sustainable energy resources (ASER).

And there is another strong materials reason: it is an utter waste to just burn oil, as it is such a valuable natural resource. The long-term interest of oil-producing countries is to use oil as a natural materials resource. Indeed, legendary Saudi oil minister Yamani’s quote, “the stone age did not end because of a lack of stones,” says it all.

Before giving my view on the roles for basic science in developing ASER, I should stress the importance of energy conservation to reduce the amount of fossil fuel needed to get the same amount and types of work done. There are materials-related issues such as improving insulation, reducing friction



“All I’m saying is *now* is the time to develop the technology to deflect an asteroid.”

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between moving parts, improving materials for natural lighting, and recycling materials. To these we can add improving waste heat use, reducing waste energy, and increasing the efficiency of current power-generation options (including renewable ones such as solar water heaters) with less pollution. Admittedly, these are not the glamor topics that may please your favorite journal’s editor, as much as the following ones, but they are critical in the short term.

Past experience teaches us that results of breakthroughs in basic science today will only start to be felt after some 15–20 years. Well, one may say, that is fine. But here is the catch. Basic scientific research in ASER decreased so much after the drop in oil prices in the early-1980s that we have a very narrow base of relevant fundamental science on which to build new technologies. That is why we

need to kick start long-term support for the sorely needed basic research now.

Now let me stick my neck out: if I were a research program manager, I’d support:

1. Exploratory, blue-sky basic research *per se* as the best proven way to stumble on new ideas[†];
2. Optics – cheap ways to use larger parts of the solar spectrum in quantum conversion systems such as photo-(bio)chemical and photovoltaic devices;
3. Heterogeneous catalysis for reduction reactions[‡] to bring us closer to the holy grail of efficient cheap artificial photosynthesis and find replacements for noble metal catalysts; and
4. Plant science.

Clearly, especially (2) and (3) present major challenges for materials research.

I am aware that my own field of photovoltaic materials is not mentioned specifically, although it definitely is in (2). Instead, I have tried to give a more holistic picture for a purpose. ASER suffered and suffers still from too many claims of *the* solution and we, the researchers, are the culprits. Even if such claims bring publicity, in the end they harm the whole area. It is my opinion that there is not *one* solution. Instead, we need to work toward a strong, sustainable mosaic of many solutions, which, as a whole, will provide *the* solution.

[†] We should, though, make sure that researchers are aware of the issues, i.e. Louis Pasteur’s famous dictum, “Chance favors the prepared mind”, applies [cf. *Nat. Mater.* (2008) 7, 93.]

[‡] Basic catalysis research today is directed mostly towards oxidation – the oil industry’s interest, as their basic starting materials are reduced carbon. Furthermore, it focuses on homogeneous catalysis, which provides only a small fraction of today’s industrial catalysts.