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From solar panel to power paint

The lecture on Monday evening was given by Prof. Kees Hummelen. After studying Chemistry at the University of Groningen, he worked for four years as a jazz pianist, before returning to Chemistry as a post-doctorate researcher. For some ten years now, he has been professor of Material Chemistry in Groningen.
Solar cells have been in use for quite some time, not only in the well-known solar panels on roof tops, but also as a power source for ultralight aircraft and the electric cars that participate in special races in Australia. “The most useful application must be the refrigerated transport of medication on the back of a camel,” says Hummelen. “However, the basic material (silicon) can no longer be produced in sufficient quantities to meet the ever-increasing demand. For that reason, more and more research is done to investigate organic chemical alternatives.”

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Professor Kees Hummelen

Glare: indefatigable panels for the largest aircraft

In the year 2006, the first Airbus A380 aircraft should roll off the production line. This gigantic aircraft will be able to carry between 550 and no less than 800 passengers, at a price per passenger that is 20% lower than that of the largest aircraft of competitor Boeing. To achieve this goal, the A380 should be as light as possible and as cheap to maintain as possible. For this reason, the most advanced materials and technologies will be used in its construction.

One of these materials is Glare (GLAssfiber REinforced), a material that has been under development for more than 20 years at the Faculty of Aerospace Engineering of Delft University of Technology.

The 1-mm thick Glare panels consist of a sandwich of alternating layers of fiberglass and aluminum that are bonded together. In comparison with aluminum, of which most aircraft are constructed, Glare has several big advantages. It is lighter, cheaper, stronger, more fire and damage resistant, and less fatigue-prone.

The entire fuselage

It is to be expected that each Airbus A380 will use around 380 square meters of Glare in its skin, mainly towards the front and rear of the cabin section. Thus, the aircraft will be around 800 kilograms lighter than with an all-aluminum body. Because this is the first time that the material will be incorporated in an aircraft on such a large scale, the manufacturer does not yet want to use Glare for all kinds of components. The application of Glare in the central section of the fuselage, where load stresses will be at their highest, will be avoided.
However, this may change in subsequent aircraft designs. Engineers at Delft are currently studying the preliminary design of the latest Airbus passenger aircraft, the A3XX. The manufacturer is now considering the use of Glare as the primary material for the fuselage. Thus, the A3XX may become the first aircraft with a fuselage completely constructed from Glare.

Convertible

Glare has been mainly developed to combat fatigue, so that it would be safer than aluminum and would not require

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In the limelight

Team Iran

As some people will probably have noticed, the team from Iran has a fifth member, Mrs Ghabel Rahmat. As an adult women, she acts as supervisor of the female student participating in the IChO, because the Iranian culture requires this. So far, she likes the Olympiad very much, she says. Much can be learned from the — sometimes major — differences between the various cultures. Unfortunately, the Iranian team cannot join in all activities. They could not participate in the dancing, for example, and they have to watch what they eat. Their guide helps them with these matters. Luckily, the team has found its way within the Dutch culture of the Olympiad. Mrs Ghabel Rahmat states that she likes it here just a little bit better than last year in India.

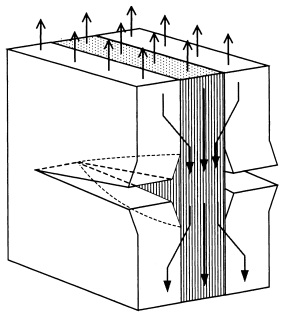
>> Glare

frequent inspection. An aircraft's wings and fuselage have to endure many and varied forces during takeoff, flight, and landing. The upward air currents required for takeoff will bend the wings upwards, while they will bend back again at the end of the flight, after landing. During takeoff, the fuselage of an aircraft is pressurized, so that the passengers can keep on breathing. During descent, the reverse process takes place. All these changing stresses may lead to cracks in the material, which will become bigger after each change. Usually these metal fatigue cracks will be found during inspection before the situation becomes critical. Sometimes things go wrong, however, as for example in 1988, when a major part of the fuselage of a Boeing 737 was ripped away and the plane had to continue its flight as a convertible, to the horror of the passengers.

2

Impact damage

A big advantage of Glare is that it prevents metal fatigue cracks from getting bigger, because there is a layer of glass fiber sandwiched between the aluminum layers. These fibers are capable of keeping the material together — even under substantial stresses — and prevent tearing. Although fatigue cracks may also develop in Glare, therefore, the construction will then still be able to bear the maximum load. Even with cracks, the aircraft can remain in the air. To prevent any cracks still occurring for whatever reason from suddenly and explosively becoming major tears, an extra thick glass fiber layer has been provided every seventy-five centimeters. This will keep the problems created by larger tears under control. The airworthiness authorities and aircraft manufacturers consider tears of up to one and a half meters as damage that should not cause an aircraft to crash.
Besides fatigue, corrosion and impact damages are also threats to aircraft. Glare is hardly bothered by corrosion, however. The corrosion that occurs is limited to the outer aluminum layer and is stopped by the first fiber layer, which is covered with a metal adhesive that is insensitive to such influences.



The fibers are capable of keeping the material together and prevent tearing

Thus, the major part of a Glare panel will remain intact and durable. Impact damage is caused by hailstones, birds colliding with the fuselage at high speeds, stones thrown in the air by the undercarriage, pieces of metal lying on the runway, or airport carts colliding with the aircraft. The glass fiber layers are so strong that such impacts will do much less damage. This will reduce repair costs and increase safety.

Forty meters in circumference

The aluminum layers in Glare have a maximum width of 1.6 meters, while the fuselage of the A380 will have a circumference of no less than forty meters. To prevent the application of large numbers of rivets to connect these comparatively small panels, so-called "splices" have been developed. In a splice, overlapping aluminum panels are glued together, in such a way that the glass fibers will extend without interruption. This creates very big Glare panels without the material losing its strength. The A380 will therefore be constructed with many less joints than conventional aircraft. Fokker Aerostructures in Papendrecht will supply the panels for the new Airbus.

Tomorrow's program

Thursday 11 July 2002

MENTORS / SCIENTIFIC OBSERVERS

07:00	Early breakfast at hotel
whole day	Marking examinations or:
09.00-16.00	Excursion, among others 'Skûtsjesilen'
19:00	Dinner at hotel
20.00-24.00	Third Jury Meeting (Business)

STUDENTS

08.00-10.00	Breakfast at hotel
13.00-20.00	Excursion 'Mega Olympic Games'

GUESTS

08:00	Breakfast at hotel
09.00-16.00	Excursion, among others 'Skûtsjesilen'
19:00	Dinner at hotel

Friesian evening

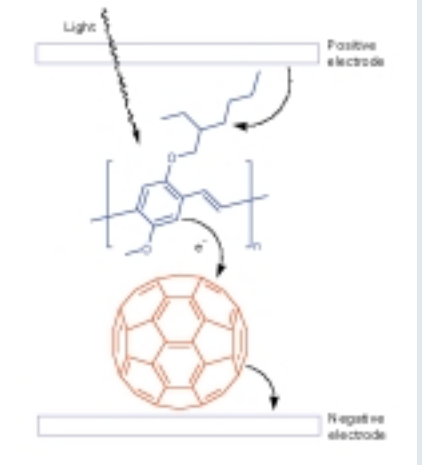
Provided the ice is sufficiently thick for the event, the so-called “Elfstedentocht” (Eleven Cities Tour), a 200-kilometer skating marathon along eleven Friesian cities, will be organized in Friesland each year. Depending on weather conditions, this marathon will be difficult to extremely severe; the average amateur skater will probably take all day to complete it (if he or she makes it at all).
On Tuesday evening, the mentors had taken part in an equally difficult marathon: the translation of the theoretical examinations. After that, they could relax and get ready for a variant of the Elfstedentocht. Apart from the dessert, this event naturally had little to do with ice, it being organized in the height of summer. Instead of skating, the mentors could enjoy a dinner with specialties from the eleven Friesian cities. They were invited to taste a specialty at each stand and have their visit recorded on a stamp card. At the end, a full card could be exchanged for a Friesian passport to prove that the card holder had made it to the finish. All in all, it was an appetizing introduction to many Dutch and Friesian specialties, among them yellow peas, eel, and herring. A Friesian dance group in traditional costumes added luster to the party.

The Friesian dance group in action

A participant on his way to the finish

>> Lecture on Chemistry

“The principle of the solar cell is based on the production of electrons under the influence of light,” explains Hummelen. “The ‘holes’ that remain are filled from the positive electrode. This principle also operates in a combination of an electron donor, (MEH)PPV, and an electron acceptor, buckminsterfullerene (C60), in which the electron transfer is extremely fast, only around 30x10-15 s — in solid state, no less!”
However, for the electron transfer to be efficient, Hummelen explains, the donor and acceptor must be in close contact over a wide area and also in close contact with the electrodes. This occurs, for example, in interpenetrating networks. “This distribution could increase the efficiency of organic solar cells from the present 3% to around 12%.” Furthermore, the donor and acceptor themselves could be modified in many ways, for example through the use of mixed polymers or self-assembly. “Dynamic superstructural copolymers that can be broken or formed at will could thus be synthesized by means of hydrogen bonding.”
The insights gained by this research will be used in the search for plastic solar cells that are more efficient, have a longer life span, are “greener”, and can be mass-produced. Hummelen: “If I were highly optimistic,



I would expect this breakthrough in 2010–2015. Even farther in the future is the ultimate product: power paint, paint that supplies power in the same way as a solar cell.”

Prof. Hummelen received a well-deserved standing ovation from the students. Despite the rigors of the examination day, he managed to fascinate his audience to such a degree that they had no trouble staying focused.

Water management day

On top of the outer dike of the Breebaart polder

Around 15% of the Netherlands lies below sea level. The entire Tuesday was therefore reserved for the “Hunze en Aa’s” district water board, which explained to the students how the Dutch population is protected against the sea. Secretary director Jacob Gunter and sector manager Jan Willem Kok began the day with an explanation of the duties of the Dutch district water boards. More information about this topic can be found in Catalyzer 7 and the info folder. After their talks, it was time for the excursions. Unfortunately we, the Catalyzer reporters, could only go with one of the buses.

The first destination was Teijin Twaron in Delfzijl, where Ate van der Werf, the assistant plant manager, explained the production process of PPTA (poly(para-phenylene terephtalamide)) used at the plant. He also fielded the critical, chemical questions of his audience quite successfully. After a trip around the plant, we were taken to the Rozema pumping station for lunch. For some of those present, this was their first opportunity to watch the sea at close range.

After lunch, the group went for a walk in the nearby Breebaart polder. This polder marks the border line between salt and fresh water and has a controlled tidal system. This has turned the polder in a unique nature reserve, which has evolved here since the late 1970s. Standing on the outer dike, the students looked across the salty estuary. Several dozen seals stared back.

After returning to the Rozema pumping station, the students were shown a short film about the reasons for the existence of this facility. Then, they could

One of the Teijin Twaron plants

In the control room

Getting a breath of air near the Ems estuary

have a look at the control room. This really made the huge difference between the sea level and the polder water level visible for them!
After this lengthy trip along typically Dutch places of interest, the tired but satisfied Olympians were brought back to Zuidbroek.

On behalf of the students, we should again like to thank the "Hunze en Aa's" water board.

Last wishes before the theoretical exam

- *Good luck!! Remember: if at first you don't succeed, so much for skydiving!* – **Guide India**
- *Hey, we're all winners! Let's keep it that way!* – **Patrick (Canada)**
- *Ha! Ha! Don't be nervous, cool! Best of luck to all.* – **Sumit (India)**
- *Stay relaxed, good luck!* – **Piter (driver)**
- *Always look on the (b)right (or left) side of life* – **Johan (Sweden)**
- *We are all winners, but good luck anyway!* – **Siim (Estonia)**
- *Chemistry is fun, just enjoy the test!* – **Maaike (Guide Hungary)**
- *I want to go home!!* – **Singapore**
- *Just want to do my best* – **Korea**
- *Will it be an exam tomorrow?!? I thought tomorrow we are supposed to go to Groningen's discos, that's all!* – **Paulius (Lithuania)**

A contribution of Sumit (India)

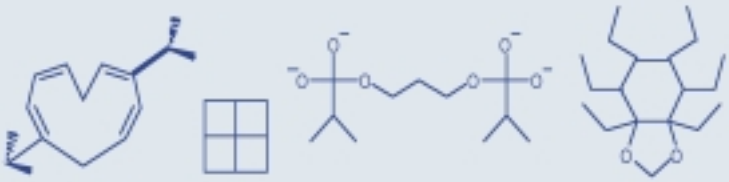
Once there was a lunatic in a mad house, laughing all day long. The doctor asked him why he laughed so much. "Because of my brother", he answered. Of course the doctor wanted to know how this came.
"Me and my brother are twins and really look alike. So whenever my brother started a fight, I got slapped. If my brother committed a crime, I went to jail. When I got a girlfriend, he married her."
"That's a pity", said the doctor, "so why are you laughing?".
"I finally took revenge: now I am dead, but my brother got burried!"

MTRO guides

The group of guides can be divided into two categories. The first includes former Olympiad participants, who (at least to this year's participants) seem reasonably "normal." Most of the guides, however, study at the MTRO, a school that trains its students for middle-management positions in tourism and recreation. To them, the Olympiad week is a practical training assignment. Unfortunately, most of them do not know much about chemistry and, strangely enough, they also seem less interested in it...
But they feel the activities for the students are cool, great, and a lot of fun. The participants, the say, are very lovable and spontaneous. It is also very impressive to see people from all these different cultures interact. It strikes them that all participants feel absolutely free to make contacts and talk to one another. The world should follow their lead!

What makes a chemist's life exciting?

- Watching the TLC solvent dry
- Mixing some HNO_3 with glycerol
- Seeing things explode
- If a chemist gets energy, he (or she, red.) becomes excited
- Having a low activation energy
- Watching your reflux rxn for 1 hr...(monitoring temp). Isn't that fun?
- Being mad is very exciting
- A couple of exciting molecules (See figure):
  - Valentene,
  - Windowpane (actual molecule!)
  - Propyl people ether
  - Spider (these have 8 legs, red.)



News

TUESDAY 9 JULY: The organization of the Chemistry Olympiad does its utmost to provide the participants with everything they need. To name just one example, Greetje Lap — the Olympiad secretary — organized a Maxi Cosi for the son of Icelandic student Helga Dögg Flosadóttir.

TUESDAY 9 JULY: The baggage of Cypriot student K. Koupparis — which was not delivered by the Schiphol Airport baggage carousel last Friday — has finally arrived. Mr Koupparis's belongings were delivered at the Zuidbroek hotel on Monday night.

What's on today's menu?

Wednesday 10 July 2002

Dinner Zuidbroek

- **Indian curry soup**
- **Veal escaloppes in tomato sauce**
- **Lasagna**
- **Vegetarian dish of the day**
- **Rice**
- **Boiled potatoes**
- **Gravy**
- **Today's vegetables**
- **Salad**

Many thanks to the Zuidbroek chef!

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