

High-tech materials for an extreme flying adventure

# Around the Earth **with the sun**

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Solar plane



*Swiss pioneers Bertrand Piccard, Solar Impulse initiator and President, and André Borschberg, CEO and co-founder, aim to circumnavigate the globe with an all-solar aircraft. They are confident that the sun alone will provide the necessary power to carry the plane through the days and nights. Supporting the project are researchers from Bayer MaterialScience, who are in the process of developing special material compounds and solutions to help build the solar-powered craft.*

A pioneering feat of aviation is nearing fruition: with its lean, angular chassis and a wingspan similar to that of an Airbus A340, the "Solar Impulse" recently flew for more than 26 hours non-stop. The energy was supplied by around 12,000 shimmering, dark-violet solar cells that fed energy to the four propellers. And the plane's maiden night flight in July 2010 in Switzerland may well have been a milestone in aviation history. In two or three years, Solar Impulse aims to fly around the world, powered only by the sun, with a wide variety of novel technologies from Bayer MaterialScience on board. "For example, we have polyurethane foams in the cockpit cladding, the engine cowling and the wings," says Johannes Seesing from Bayer MaterialScience. Plastic films and upholstery elements made from Bayer raw materials also play an important role.

In the next model of the solar-powered aircraft, the proportion of Bayer

materials could rise again significantly. "Since March 2010, Bayer MaterialScience has been an official partner to the Solar Impulse project," explains Seesing. The aim of the cooperation is to develop tailor-made, lightweight, high-performance materials and subject them to rigorous testing.

### Energy requirements no more than that of a scooter

The second prototype – HB-SIB – will be even more optimized. Basically it must get by with an amount of energy comparable to a small motorcycle. If everything goes according to plan, the airplane will take off to circle the world in 2013.

Daring projects have a long tradition in the Piccard family – as do their successful completion: grandfather Auguste was the first person to enter the stratosphere with a gas-filled balloon, and fifty years ago Piccard's father dived in a special capsule down to a depth



Airborne adventure: the solar plane is scheduled to fly around the world on solar power in 2013. Pilots Bertrand Piccard (left) and André Borschberg celebrate their first successful night flight.





Partnership of air travel pioneers: (left to right) initiator and President of Solar Impulse Bertrand Piccard, Chairman of the Board of Management of Bayer MaterialScience Patrick Thomas and André Borschberg, CEO, co-founder and pilot of Solar Impulse, plan to jointly move the project forward. High-tech plastics from Bayer MaterialScience are to be used in the cockpit of the solar plane.

of around 11,000 meters to the deepest point of the seas. Through Solar Impulse, Piccard, Borschberg and their team want to demonstrate what can be achieved today with renewable energy and high-tech materials. For this feat alone, Solar Impulse has a large number of notable

supporters, ranging from the grandsons of Jules Verne and Charles Lindbergh to Nobel Peace Prize-winner Al Gore.

The aircraft engineers want to start the design of the second airplane as early as 2011. "It will consist of sandwich elements – carbon fibers impregnated

with epoxy resin that cover honeycomb structures or foam cores," says Seesing. The Bayer team should now be able to make this material even more stable by reinforcing the epoxy resin with tiny nanometer-sized tubes of carbon atoms linked together like a honeycomb – carbon nanotubes, or CNTs for short, which the company markets under the brand name Baytubes®.

## Milestones of aviation history

- 1709** First model of a hot-air balloon by Bartolomeu de Gusmao
- 1783** Hot-air balloon invented by the Montgolfier brothers
- 1784** First crossing of the English Channel in a balloon
- 1891** Otto Lilienthal undertakes first manned flight in a glider
- 1900** First rigid body dirigible (F. von Zeppelin)
- 1903** First powered, controlled flight by the Wright brothers
- 1909** First plane crossing of the English Channel (Louis Blériot)
- 1910** Commercial air travel with airships begins
- 1919** Start of scheduled airplane flight services
- 1927** Charles Lindbergh flies nonstop from New York to Paris for the first time
- 1935** Start of scheduled flights over the Pacific
- 1939** Scheduled air traffic over the North Atlantic begins
- 1947** First supersonic flight by Chuck Yeager in the Bell X-1
- 1949** First nonstop flight around the globe
- 1952** Scheduled air traffic with jet planes begins
- 1967** First transatlantic flight in a helicopter
- 1968** Tupolev Tu-144 is the world's first supersonic passenger plane
- 1973** Maiden flight of the Airbus A300 (joint European production)
- 1976** Supersonic passenger service begins with Concorde
- 1979** Human-powered aircraft crosses the English Channel for the first time
- 1981** Solar-powered aircraft crosses the English Channel
- 1988** First hydrogen-powered passenger plane (Tupolev Tu-155)
- 1999** Bertrand Piccard and Brian Jones fly nonstop around the world in a gas balloon for the first time

## Nanotechnology makes the plane a lightweight

"The CNTs should significantly improve the mechanical properties of the material and help to make the aircraft lighter," says Dr. Björn Henninger, who is responsible for the development of Baytubes®-modified epoxy systems at Bayer MaterialScience. Explorer Piccard hopes that this will bring more thrust: "Nanotechnology has always fascinated me. With Bayer MaterialScience we can now make our plane even lighter and more efficient." Adds André Borschberg, CEO, co-founder and pilot of Solar Impulse, "This technology is crucial for the success of the project, especially in terms of the development of innovative material solutions to reduce energy consumption."

The nanotube-reinforced material should offer yet another advantage for the flying adventure, as the Bayer experts are working on making sure that it will not expand too much when subjected to heat. "After all, the plane



Driving force: equipped with some 12,000 solar cells (photo, left), the sun plane will circle the globe a few years from now. Johannes Seesing (photo, right) is organizing the collaboration between Solar Impulse and Bayer MaterialScience, which has been an official partner of the Swiss initiative since early 2010 and supports the project with technical know-how and innovative materials.

will have to withstand huge variations in temperature," says Henninger. During the day, the pilots will ascend to an altitude of around 12,000 meters. That means about minus 50 degrees Celsius. But at night, the solar aircraft – powered by solar energy stored in lithium-ion batteries – will drop to an altitude of 1,500 meters, where the temperature can be around 30 degrees Celsius. "When different materials are combined, temperature fluctuations like that could have dramatic consequences. If the materials expand to varying extents, the composite material can crack and break," explains Henninger.

### Energy-efficient batteries with carbon nanotubes

An additional benefit from the use of Baytubes® could come in terms of energy efficiency. "We are currently examining the question of whether the capacity of the lithium ion batteries can be improved with the help of CNTs," reports Dr. Egbert Figgemeier, the person at Bayer MaterialScience responsible for the development of Baytubes®-modified special applications. This is because carbon nanotubes conduct electricity better than graphite, the classic material used for electrodes in batteries. The barrier film, with which the electrochemical processes on the positive and negative poles of the battery are kept apart, could also be made

more stable and thinner with nanotubes. Says Figgemeier, "A success in this field would also be a breakthrough for other areas, such as the development of future electric cars." Last but not least, the carbon nanotubes could also make bolts and other metal connections stronger. Aluminum reinforced with Baytubes®, for example, has already been successfully tested in bolts for high-tech mountain bikes.

But nanotechnology is not the only area in which Bayer researchers are literally lending wings to the project; they are also working on cockpit parts such as the windshield, which is currently made of two highly transparent Makrofol® films with a cushion of air in between. Because condensation quickly forms when the temperature drops and vision is impaired, the plane builders are on the lookout for alternatives. Notes Seesing, "It may be that a compact sheet of Makrolon is the better choice even though it is slightly heavier."

Another area of focus for the Bayer experts in the Solar Impulse project is the production of suitable coatings to improve the properties of the fabrics on board. "This could include items like the pilots' clothes and the seat coverings," says Seesing. There is also room for improvement as regards the design of the pilot seat, which is a hard shell with no possibility of adjustment. It's a real pain for the pilots who, although they will alternate, have to stick it out

in the seat for several days and nights. In all, the trip will take 25 days and nights, and the plane will fly at an average speed of about 75 km/h. "At the moment, we are seeking a partner with whom we can develop a seat that is lightweight but nevertheless comfortable," says Seesing. The Bayer research team can, for example, contribute suitable flexible foams or inflatable films that dissipate moisture.

### Proving ground for a future with renewable energy

Whether the ideas from the Bayer experts will actually materialize in the long run remains to be seen. For them, too, the solar-powered plane project is a very broad proving ground. "We must take a little more risk than we do in our everyday business," says Seesing, "and we have permission to do so."

And should the first manned flight around the world with a solar-powered airplane succeed, it would be an enormous success not only for Solar Impulse, it would also bolster people's confidence in a future with renewable energy.

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