Joint research at Eindhoven University of Technology and Fraunhofer ISE

New efficiency record for important class of solar cells

Physicist Bram Hoex (29) and coworkers from the Eindhoven University of Technology (TU/e) in collaboration with the Fraunhofer ISE institute in Germany have improved the efficiency of an important type of solar cell (n-type PERL) from 21.9 to 23.2 per cent (a relative improvement of 6 per cent). This new record was presented on Wednesday 14 May at a major solar energy conference in San Diego, USA. The efficiency improvement is achieved by the application of an ultra-thin aluminum oxide layer at the front of the solar cell, and it brings a breakthrough in the use of solar energy a step closer.

An improvement of more than 1 per cent (in absolute terms) may appear modest at first glance. Increasing the solar cell efficiency is, however, a very effective way to reduce the solar electricity costs. The costs of applying the thin layer of aluminum oxide are expected to be relatively low. This will mean a significant reduction in the cost of producing solar electricity.

Ultra-thin
A crucial problem to achieve high efficiencies on n-type silicon - a material with a very high efficiency potential - was solved by the aluminum oxide-layer developed at TU/e. This was demonstrated by the application of these layers on solar cells fabricated at Fraunhofer ISE resulting in very high efficiencies of 23.2%. The best n-type PERL cell reported to date exhibited a conversion efficiency of 21.9 %, mainly limited by electronic losses at the front surface of the solar cell. Aluminum oxide contains an unprecedented high level of built-in negative charges, through which these – normally significant – electronic losses at the front surface of the solar cell are almost entirely eliminated. The ultra-thin aluminum oxide layers have solved a major technological challenge in the field of silicon solar cells and numerous solar cell manufacturers have already shown their interest.

Industrial collaboration
Hoex gained his PhD last week at the Applied Physics department of the TU/e for his work in the Plasma & Materials Processing (PMP) group lead by professor Richard van de Sanden and assistant professor Erwin Kessels. This group specializes in the growth of extremely thin layers. The aluminum oxide films were grown with the relative new atomic layer deposition technique in a setup supplied by Oxford Instruments which was developed with contributions of the PMP group. Another process developed by the PMP group for the deposition of the silicon nitride antireflection coating is currently licensed by the Dutch company OTB Solar and is employed by various leading solar cell manufacturers.

Promising
Solar cells are widely considered as an important part of our future energy supply. Sunlight is an abundant source of energy, and solar cells can conveniently be installed on surfaces with no other useful purpose. Solar energy also offers opportunities for usage in developing countries, many of which have high levels of sunshine. Within ten to fifteen years the costs of electricity generated by solar cells is expected to be comparable to that of ‘conventional’ electricity from fossil fuels. This technology breakthrough removes one of the main barriers for the commercial application of this type of high-efficiency solar cells. For this reason, part of Hoex’s PhD research project was paid for by three Dutch ministries: Economic Affairs; Education, Culture and Science; and Housing, Spatial Planning and the Environment.