Project Title:	'Band Structural Engineering of TiO2 for Efficient Solar Cells'
Principle Investigator:	Prof Guosheng Shao (University of Bolton)
Project duration:	01/11/07 – 31/10/08
Grant Value:	£35,071

The urgent need to reverse the business-as-usual growth path in global warming in the next two decades to avoid serious if not catastrophic climate change, necessitates action for us to reduce dependence on fossil fuels and switch to various carbon-free renewable energy resources. In the UK, the government has set up ambitious targets for the production of electricity from renewable sources, 10% of electricity by 2010 and 15% by 2020, and solar power is expected to make a significant contribution to this. Therefore the development of low-cost, efficient and environmentally friendly photovoltaic technologies will be of enormous benefit to society as a whole. It will also provide significant business opportunities internationally as countries strive to move towards more sustainable ways of generating electricity.

Although semiconductor solar cells have been extensively explored as a clean means to convert solar energy into electricity (photovoltaic or photoelectric), the dominant photovoltaic technologies of today suffer from a great setback of high cost and lengthy pay-back period. This is restricting the take-up of these cells and therefore the amount of electricity which can be generated this way. So it is highly desirable to develop thin-film titanium dioxide (TiO2) solar cells using low-cost deposition technologies. These techniques involve applying a thin coating of one material to the surface of another usually by coaxing the coating material from a vaporous or dissolved state using electricity, high heat, chemical reactions, evaporation, or other techniques. By doing this solar cells can be created using only a small amount of the expensive photovoltaic material making them significantly cheaper to produce than those produced using more traditional techniques. However solar cells produced using this technique currently achieve much lower levels of energy conversion efficiency than silicon cells.

This project is aimed at increasing the energy conversion efficiency of Titanium Dioxide which can be applied to cheaper materials, such as glass, plastics etc, using deposition to create solar cells. Currently the material can only convert 5% of the suns energy into electrical energy, the amount of the solar spectrum photovoltaic cells can absorb is called its band gap and TiO2 can only absorb ultraviolet irradiance. This project explored the possibility of using the process of doping to narrow TiO2's band gap thereby increasing the amount of the suns energy it can absorb to up to 50%. Doping is the process of is the process of introducing impurities into an extremely pure semiconductor (in this case TiO2) to change its electrical properties. The effectiveness of using such a technique for narrowing Titanium Dioxide's band gap was explored both through theoretical modeling and computer simulations. This doped TiO2 material was then fabricated in a laboratory as part of the project

The theoretical modelling work has helped to identify doping elements that allow significant reduction of the energy gap permitting energy conversion of the solar irradiance from the ultraviolet (<5% of solar radiation) down to the long wavelength visible light or even the infrared regions (>50% of solar radiation).

This project has led to two applications for patents and a spin off company. Prof. Shao has also received a further £933,050 funding from the Technology Strategy Board to continue his research into low cost, highly efficient photovoltaic solar cells. As a result of the possible applications of the research two companies involved in the project, Kleentec International Plc and Crowberry Energy, are working on a related project with funding (£10,000) from Metric.