Thin film breakthroughs

Thin films may keep household mirrors gleaming, but Professor Guifu Zou has loftier aspirations for the applications of these chemical coatings. Here, he discusses how his research has progressed to date and outlines his plans for the future.

Could you briefly outline the activities taking place in your research laboratory?

Our lab focuses on the growth and property-tunability of thin films for their use as multifunctional materials. In some of our most recent projects, we are attempting to determine an efficient solution-processing method and fabricate large areas of thin film for superconducting nanowire single photon detectors. We are also attempting to design thin films with the desired properties by polymer-assisted deposition (PAD), as well as developing novel quantum dots based on PAD thin films for solar cells.

What does PAD entail, and what advantages does the technique offer over traditional methods of thin film production?

A film precursor is generated by the binding of metal ions to polymers – a technique that confers several advantages. For instance, the formation of covalent complexes between the lone pairs of electrons on the polymer’s nitrogen atoms and metal cations makes it possible to prepare almost any metal precursor solution. This is impossible to achieve by more commonly employed chemical solution deposition techniques, and makes the physical filtration of unbound low molecular weight ions unnecessary.

Scaling up solar energy

Although sunlight is the Earth’s predominant source of energy, harnessing this bountiful resource can be costly. Researchers at Soochow University, China, are paving the way for a new generation of ‘thin film’ solar cells – devices whose manufacture is easier on both the wallet and the environment.

THE SUN’S LARGELY untapped potential as a renewable energy source can be attributed in part to the expense of fabricating solar panels. If scientists are to make the most of the great star of our Solar System, they must find cheaper alternatives to the costly photovoltaic cells (PVCs) presently manufactured.

Indeed, the solar panels currently in use fall into the category of first-generation PVCs. Although these cells are efficient in their performance, they are rigid and require high-temperature and vacuum treatments. More recently, a second generation of PVCs has been incepted – such as those composed of amorphous silicon – but they are also produced by energy-intensive manufacturing processes and consist of scarce elements.

A research group at Soochow University is taking a novel approach to thin film solar cell construction, paving the way for a third generation of PVCs – nanostructures integrated with thin films. Led by Professor Guifu Zou, the researchers are developing solution-processed photovoltaic materials. PVCs of this type boast unrivalled cost-effectiveness in the manufacturing process, have great physical flexibility and are comprised of renewable materials. The group’s advances in the field of thin film technology could also lead to the development of a range of other innovative appliances and industrial processes.

POLYMER-ASSISTED DEPOSITION

Thin films are stratified materials of nano- or micro-scale thickness. Despite their delicate proportions, coating objects with thin films confers the properties of durability and chemical inertness. Additionally, thin films can be endowed with ferromagnetic and ferroelectric characteristics, which are very useful in the development of computer hardware. Indeed, the physical properties of thin films are tunable and can be tailored to fit a variety of purposes.
Can you provide some everyday examples of thin film applications?

Thin films chiefly benefit optical coatings and electronic semiconductor devices. One familiar application of thin films is the household mirror, where a ceramic coating protects against corrosion, oxidation and wear. In the high-tech field, thin films are widely used for computer memory, batteries, solar cells and even drug delivery.

How might your research on thin films benefit solar photovoltaic cell technology?

PAD allows for the production of photovoltaic cell technology with cheaper fabrication costs than traditional alternatives, and establishes a platform on which novel hybrid solar cells operate. Furthermore, our research will contribute to basic scientific research on quantum dots and material synthesis for photovoltaic devices, driving the breakthrough of a third generation of solar cells.

What are the most challenging and enjoyable aspects of your research?

Our greatest challenge lies in the development of thin film growth techniques that satisfy industrial demand. However, much work remains before this challenge can be overcome. For instance, we must determine the chemistry which underpins the deposition of ions on the polymer substrate during the PAD process. In approaching and surmounting challenges such as this, we derive great enjoyment from our research.

What's next for your research group?

Our research focus will progress in two directions. We hope to build on the PAD technique, leading to the design of functional thin films with desirable properties, and to construct a solution-processing photovoltaic device. Our ultimate goal is to develop an efficient, low-cost and easy setup procedure for industrial thin film production.

BREAKTHROUGH OF THIN FILM GROWTH

OBJECTIVES

- To create controllable growth of thin films and nanostructures
- To investigate nano-composite thin film design for multifunctional materials and its applications

KEY COLLABORATORS

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GUIFU ZOU received his PhD degree in Chemistry from the University of Science and Technology of China in 2006. Following a postdoctoral position at Umea University [Sweden], he was appointed as a Director’s Postdoctoral Fellow at Los Alamos National Laboratory (LANL) in 2007. Dr Zou joined in Soochow University in 2011.