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TRACKING TRENDS & PERFORMANCE IN BASIC RESEARCH

AUTHOR COMMENTARIES - 2009

April 2009

PDF

Nir Tessler

Featured Scientist from *Essential Science Indicators*SM

In February 2009, Essential Science Indicators *from Thomson Reuters welcomed Dr. Nir Tessler to the top 1% in the field of Chemistry. Prior to this, his work has also appeared in the top 1% in the field of Materials Science. His overall record in our databases includes 66 papers cited a total of 3,021 times between January 1, 1998 and December 31, 2008.*

Dr. Tessler is a Professor in the Electrical Engineering Department of The Technion – Israel Institute of Technology in Haifa, Israel.

In this interview, he talks with ScienceWatch.com *about his highly cited work.*

SW: Would you tell us a bit about your educational background and research experiences?

I received a B.Sc. summa cum laude from the Electrical Engineering department, The Technion - Israel Institute of Technology in 1989. I then continued towards an M.Sc., studying semiconductor optical amplifiers and their nonlinear response. This was followed by research that went deeper into semiconductor device physics, and in 1995 I submitted my D.Sc. dissertation on charge carrier dynamics in quantum well lasers and the implications for ultrafast III-V lasers. Towards the end of my Ph.D., I decided that I wanted to change fields of research, and my main preference was biology.

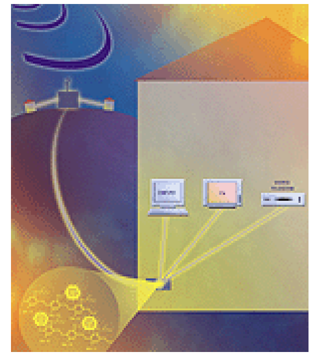
At the time, it was too early for biologists to appreciate the potential contribution of electrical engineers and I could only go midway, and applied to groups in organic electronics. With the generous help of the Rothschild Fellowship I joined the group of Professor Sir Richard Friend at the Cavendish Laboratory at the University of Cambridge. It was at Cavendish where I learned what one means by polymer, let alone by organic polymer. Looking back, I think that the foundations of my knowledge and research attitude towards organic semiconductors were laid during my first two years at Cavendish.

+enlarge

Today, I have an active research group at the Nanoelectronic Center, which is part of the Electrical Engineering department at The Technion. The topics largely deal with the use and understanding of semiconducting molecules. Although most people know my name as the one who made the first optically pumped polymer laser this is probably the only application that is not directly pursued in my lab. I also get the opportunity to glance towards biology through collaboration with colleagues on "conjugated peptides" and on "alternative energy sources using field-grown plants."

SW: What would you say is the main focus of your work, and what about this area drew your interest?

My main focus is on making new device architectures, developing new materials, and understanding the device chemical-physics behind it all. I would say that I was drawn because I found it exciting, and so far, it is still so.



Nano-composites for local network.

SW: Your most-cited paper is the 1998 *Science* article, "Integrated optoelectronic devices based on conjugated polymers." Would you talk about this paper, its goals, findings, and significance for the field?

This work took place while I was at Cavendish, and it was roughly when I was becoming a member of staff through an Engineering and Physical Sciences Research Council advanced fellowship. As I recall, I was working with my two hands in the glove box when a post-doc there at the time I didn't know too well said something like "Wow, I have never seen a transistor as good as the one I just made." My immediate reaction was to challenge him and say, "If it is so good then it should be able to turn the light on in the LED I am making." As some of your readers know, my colleague is now a professor at Cavendish (Professor Henning Sirringhaus). What I am trying to say is that there were no "plans," "goals," or "strategy," but it was rather two guys having fun at the lab.

Of course after that we finished "playing" and showed the result to Professor Friend, and we had several discussions where we came to realize the huge scientific and commercial potential impact of this work. It was the first report of an all-organic smart-pixel, which is the basic structure behind display screens. It also showed that it is possible to integrate (in a beneficial manner) different organic devices and thus create a higher hierarchy.

I believe that this work made an impact because it ignited the imagination of many who decided to devote more of their effort towards this topic. In the commercial world, this work and its accompanying patent started the effort towards the establishment of the company known today as Plastic Logic. The creation of this company and others around the world is serving as a positive feedback to the scientific community thus pushing this field even faster.

Before concluding I should also mention that at the same time a very similar work was being carried out at Bell Labs and the paper by Ananth Dodabalapur was published shortly after ours.

SW: One of your more recent papers is from *Nano Letters*, "Tuning energetic levels in nanocrystal quantum dots through surface manipulations." Would you tell our readers a little bit about this paper?

"My main focus is on making new device architectures, developing new materials, and understanding the device chemical-physics behind it all."

In our group we have been working on extending the functionality of polymer-based devices from the visible to the NIR part of the spectrum by adding nanocrystals to the semiconducting polymer matrix. One of the obstacles was that the energy level alignment between conjugated polymers and nanocrystals of choice was not always favorable for the application we sought (LEDs require type I and solar cells require type II alignment). As we are electrical engineers it is most important for us to control the properties of the building blocks being used to make advanced devices. In standard devices the tuning of energy level alignment of two materials is one of the existing tools.

We tried to find a solution to that by applying the well-known effect of energy level tuning through the assembly of dipole-carrying molecules onto surfaces. As it turned out, we were rather naïve expecting that molecules on the surface of a 5nm diameter nanocrystal would create an effect identical to molecules on flat (2D) surfaces.

As the paper shows, we were able to demonstrate that through the choice of specific ligands (molecules) it is possible to tune the position of the nanocrystal's energy levels. However, we still can't explain what the exact mechanism behind it is and we are definitely far from understanding why the effect is different between 2nm and 5nm diameter nanocrystals. This work was a success mainly due to an excellent Ph.D. student in my group, Michal Soreni-Harari.

SW: What are the potential applications that might stem from your research?

I hope that one day we will see real fully integrated all-plastic optoelectronic devices. The work around the world shows that one can print batteries, print transistors, print solar cells, print displays, print RF transceivers…if we know how to functionally integrate them all, we will have smart applications that could be designed on the PC and printed out right away with close to zero development cycle. When this happens, consumer electronics will take on a whole new meaning.

SW: What would you like to convey to the general public about your work?

I think that to the general public I would say that although all my answers above give the impression that it is all fun and successful, it is just an impression. In fact, our work consists of working hard and failing most of the time. The occasional success is what keeps us going. It would be great if we could convince the general public that what we do in academia is important for the future despite the fact that most of the time there is no immediate benefit from our work.

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Nir Tessler's current most-cited paper in *Essential Science Indicators*, with 1,049 cites:

Sirringhaus H, Tessler N, Friend RH, "Integrated optoelectronic devices based on conjugated polymers," *Science* 280(5370): 1741-4, 12 June 1998. Source: *Essential Science Indicators* from Thomson Reuters.

Additional Information:

Ananth Dodabalapur Interview for the Special Topic of Organic Thin-Film Conductors.

Richard Friend Interview for the Special Topic of Conducting Polymers.

KEYWORDS: SEMICONDUCTOR DEVICE PHYSICS, CHARGE CARRIER DYNAMICS, QUANTUM WELL LASERS, ORGANIC POLYMERS, ORGANIC SEMICONDUCTORS, OPTOELECTRONIC DEVICES, CONJUGATED POLYMERS, NANOCRYSTAL QUANTUM DOTS.

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