ELECTRON TRANSPORT IN NANOCRYSTAL ASSEMBLIES
WORKSHOP SUMMARY

The workshop was co-sponsored by the William I. Fine Theoretical Physics Institute (FTPI) and the Nanoparticle Based Materials group of the Material Research Science and Engineering Center at the University of Minnesota. It was organized by Alexander Efros (Naval RL) and Boris Shklovskii (FTPI). This exciting event was held in Minneapolis from Friday, June 14, to Sunday, June 16, 2013**.**

The recent progress in the creation of conducting media made of periodic arrays of semiconductor nano-crystals and quantum dot nano-crystal solids has drawn a great deal of attention. These nano-crystal structures are emerging as a new class of solution-processable materials for low-cost, flexible, thin-film electronics. Still, the mechanism of electron transport of these structures is not understood.

The goal of this workshop was to bring together the leading experts, faculty, and young researchers of engineering departments across the University working in this field. To this end we had 15 invited talks of 40 minutes over the 2.5 days along with significant time dedicated to discussions and an extensive poster session. The participation of young researchers (graduate students and postdocs) was especially encouraged. They attended all talks and presented 4 short talks during special section.

The workshop started with an excellent talk by David Norris (ETH Zurich), which focused on important for transport question of physics of impurity doping of colloidal semiconductor nano-crystals, followed by presentation by Vladimir Bulovic (MIT) on applications of doping to charge transport in FETs, LEDs, and Solar Cells. Second morning session was central in this workshop and featured talks of two leaders of the field. Cherie Kagan (University of Pennsylvania) presented pioneering research, where she using doping by In demonstrated electron mobilities by one or even two orders of magnitude larger than other researches and interpreted this discovery as a band like transport. On the other hand, **Philippe Guyot Sionnest (**University of Chicago) argued against this interpretation and presented his excellent results on transport in weakly coupled quantum dot solids and applications to infrared detection. The afternoon section started by the talk of **Brian Skinner** (University of Minnesota) who presented first theory of hopping transport in arrays of metallic and semiconductor nano-crystal and continued by **Hunter McDaniel (**Los Alamos NL) dealing with challenges of QD-Transport with the Sensitized Solar Cell Architecture.

The next day of the workshop started with talks by **Chris Leighton** (University of Minnesota), who reported crossover from nanoscopic intergranular hopping to conventional charge transport in FeS2 thin films and **Herve Aubin** (CNRS, Paris) about electronic transport in nanoparticle arrays, both in remarkable agreement with hopping theory proposed by Skinner.

After the coffee break, **Steve Erwin** (Naval RL) presented his theoretical study of nano-crystal doping by arrested cation exchange and **Matthew Beard (**NREL) spoke on PbS and PbSe quantum dots solar cells for high efficiency solar photo-conversion. In the afternoon, **Alexander Efros** (Naval RL) presented new theory of photoconductivity of ordered array of nano-crystals**,** and **Matt Law (**University of California, Irvine) talked about his results on matrix engineering to improve charge transport in quantum dot solids. The day ended an hour session, where 4 postdocs and students presented excellent talks on different aspects of transport in nano-crystal systems. In the morning of the last day of the workshop, **Jaeyoung Jang** (University of Chicago) discussed the role of surface chemistry in the conductivity of nano-crystal assemblies and **Igor Zutic** (University of Buffalo) proposed new ideas for tailoring magnetism in quantum dot. Workshop closed by the talk of the founder of nano-crystal field **Christopher Murray** (University of Pennsylvania) with the visionary talk about future of engineering optical absorption and charge transport in self-assembled multi-component nano-crystal superlattices.

By all accounts, the workshop was a great success. It achieved its main goal of facilitating conversations between theorists and experimentalists and a cross-dialog between researchers in various subfields. It conveyed the breadth and excitement of this very young field of physics, which has grown on the intersection of semiconductor physics and chemistry. Ideas, contact, and collaborations initiated during the workshop will certainly propel the field in the years to come.

The workshop had enormous educational value: it was attended by many graduate students and postdocs from Physics, Chemistry, Electric Engineering, Mechanical Engineering and Chemical Engineering Departments.

Summary by Boris Shklovskii
Workshop website: http://www.ftpi.umn.edu/workshops/2012-2013/etnca2013/index.html