Materials Science and Engineering Department

Winter Seminar Series

The Third Perovskite Revolution: Why, What and Why Not Yet?

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3-4PM | Hill Seminar Room (LeBow 240)

The discovery of the metal halide perovskite (MHP) as a photovoltaic (PV) absorber and the subsequent meteoritic rise of the efficiency of perovskite solar cells (PSC) are among the most important modern scientific breakthroughs. Today the term 'perovskite' is used to designate the crystalline structure of a wide variety of ABX3 ionic compounds. This name was coined for a specific mineral, calcium titanate (CaTiO3). It was discovered in the Ural Mountains, Russia. The first sample of the mineral was transferred from Saint Petersburg to Berlin in 1839 by the Russian mineralogist Alexander Kämmerer, who gave the sample for further investigation to the German crystallographer Gustav Rose (1798–1873). Rose named the mineral after the Russian politician and mineralogist Lev Perovski. Lecture will start with a history of this discovery. In 1987, the Nobel Prize in Physics was awarded to Georg Bednorz and Alex Müller for the discovery of High Temperature Superconductivity. Their Nobel Lecture was titled: "Perovskite-Type Oxides: The New Approach for High-Tc Superconductivity". Another Nobel Prize in physics (2007) was awarded for the discovery of Giant Magnetoresistance (GMR), an abnormally high change in resistance of a conductor when it is placed in an external magnetic field. This quantum mechanical effect is observed in an alternating sequence of ferromagnetic and non-magnetic conductive nanolayers. The discovery of the GMR gave rise to an increased interest in finding related effects among bulk materials. Resistance change in an applied magnetic field several magnitudes higher than for GMR was observed in certain manganese perovskites. The observed phenomenon became known as colossal magnetoresistance (CMR). I consider the development of highly efficient MHP photovoltaics as the third "perovskite revolution" of modern time. In 2007, PSC efficiency didn't exceed 3 %, but today it is above 25 %. Today's manufacturing is dominated by silicon solar panels that have almost reached their maximum efficiency. The PSC development has changed the situation, paving the way to create the so-called tandem perovskite/silicon cells, with 30% already demonstrated. The prospect of overcoming 35% is now discussed. The main obstacle is that the PSC efficiency deteriorates quite rapidly under PV operation. Lecture will be finalized with a short review of our research toward the improvement of PSC operating stability.

Dr. Eugene A. Katz received his MSc degree (1982) in Semiconductor Materials Science and Ph. D. (1990) in solid state physics from the National University of Science and Technology "MISIS", Moscow. In 1995, he joined the Ben-Gurion University of the Negev and has been working in the Department for Solar Energy and Environmental Physics ever since (now as a full professor). His research interests include studies of a wide range of materials and devices for solar energy conversion, such as organic and perovskite-based photovoltaics, concentrator solar cells operated at ultra-high solar concentration (up to 10,000 suns), etc. He has published more than 140 peer-reviewed papers on these topics (including those in Nature Energy, Advanced Materials, Energy & Environmental Science, etc, as well as popular scientific book and a number of popular articles on history of science and fullerene-like structures in nanomaterials, living organisms and architecture. Based on the latter activity he has developed and is teaching an unique interdisciplinary course "Bridges between fine art, architecture, mathematics and natural sciences: cases of fullerenes, polyhedra, symmetry". Prof. Katz was awarded the IAAM Medal (by the International Association of Advanced Materials) for the outstanding research in the field of New Energy Materials & Technology.

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