Auburn University PV Cell

Drew S. Addison

There are many different skills electrical engineers have that are pertinent to the field of photovoltaics. Power engineering, PCB design, and control systems. However, the actual fabrication of photovoltaic cells is something many engineers with some of the aforementioned skill sets may overlook. Electrical engineers are usually given some exposure to how a diode or transistor works. These same engineers usually lack an understanding of all of the steps required to produce a transistor or a photovoltaic cell. Auburn University ECE is well-equipped to address this lack of understanding due to microelectronic fabrication lab space. Taking the available tools in this lab into consideration allows engineers to develop a proposed process for the fabrication of a simple photovoltaic cell. The goal of this presentation is to present the tools users have access to in Auburn University's clean room. How the tools work and common applications of the tools will also be addressed. After considering the tools a process or traveler is proposed. Each step in the process is explained and documentation of the progress of processing on a test sample will also be presented. Finally, the testing done on the sample will be reported along with potential improvements on this process as process development is always needed in microelectronic fabrication to attempt to optimize results.

Printed Solar Cells

Aarsh Patel

In the past few decades, the fabrication of solar cells has been considered as one of the most promising ways to meet the increasing energy demands to support the development of modern society as well as to control the environmental pollution caused by the combustion of fossil fuels. A number of different types of solar cells, such as silicon solar cells (Si), Cu-based chalcogenides (Cu(In,Ga)Se2/Cu2ZnSn(S,Se)4) thin film solar cells (TFSC), dye-sensitized solar cells (DSSC), organic solar cells (OSC), and perovskite solar cells (PVSC), have been implemented in the photovoltaic technology. However, the high manufacturing costs of solar cells is one of the major obstacles for their wide-scale application. Inkjet printing (IJP) technology, adapted from home and office printing, has proven to be an essential research tool and industrial manufacturing technique in a wide range of printed electronic technologies, including optoelectronics. Its primary advantage over other deposition methods is the low-cost and maskless on-demand patterning, which offers unmatched freedom-of-design. Additional benefits include the efficient use of materials, contactless high-resolution deposition, and scalability, enabling rapid translation of learning from small-scale, laboratory-based research into large-scale industrial roll-to-roll manufacturing. In the development of organic solar cells (OSCs), IJP has enabled the printing of many of the multiple functional layers which comprise the complete cell as part of an additive printing scheme. Although IJP is only recently employed in perovskite solar cell (PeSC) fabrication, it is already showing great promise and is anticipated to find broader application with this class of materials. On the other hand, overcoming some limitations of the IJP such as production speed, screen printing serves as other alternative to producing solar cells quickly.

History of PV Technology

Juan A. Real Salomon

Photovoltaic technology started with the discovery of the photovoltaic effect in the 1800's, also known as the "Becquerel Effect", named after his discoverer. This project dives into the development of semiconductor based solar energy; its milestones, and the people who made it possible to turn it from an inefficient gimmick to a usable power source. Historical context is paramount in understanding the development of any technology and photovoltaics is no exception. From Project Vanguard and the space race to the oil crisis of the 1970's, whether politically or economically motivated, or motivated by new advancements such as the invention of the hetero-junction. Consequently, the modern context can be examined to understand its implications for the near future of photovoltaic technology. Additionally, the project means to convey to the audience that the landscape of photovoltaic technology development is very fast paced and constantly changing and improving. This means that even the 2010's are considered to be 'history' in this context even if the word has a colloquial connotation of events being in the somewhat distance past. According to the National Renewable Energy Laboratory, since 2010, the total photovoltaic deployment in the United States has increased at a compound annual growth rate (CAGR) of 54%. The Department of Energy's Sunshot Initiative intends to continue this trend by achieving cost parity with other more traditional energy generation. Finally, the project goes into less pivotal yet intriguing aspects surrounding photovoltaic technology, like how an inventor might have made a working solar generator about 40 years before Bell Laboratories and how it might be linked to his kidnapping in 1909 with rough links to Standard Oil's anti-competitive practices and allegedly suppressed by them.

Solar-Hydro Power Synergy, a Study on Solar-Hydro Integration

Tarek M. Lotfi

In my upcoming speech, I will delve into the integration of a 30MW solar farm as a strategic solution to mitigate supply and demand fluctuations encountered by a hydropower plant. This discussion will encompass an evaluation of the advantages and disadvantages of utilizing floating solar cells. A significant part of the presentation will be dedicated to identifying the most suitable location for this solar farm, with a focus on the use of thin-film technology to maximize power output while ensuring peak performance. Additionally, I will explore the role of battery bank storage systems in this context. To conclude, I will address homeowners' concerns regarding the potential impact of these developments on the dam lake environment.

Photovoltaic Technologies – Perovskite Solar cells

Varun Viswanathan

In today's world, renewable energy plays a crucial role in all sectors. Solar energy is one of the main areas of renewable energy research and is expected to contribute to about 4% of world electricity production by 2023. Silicon has been the long-standing industrial standard material used in solar cells. But its cost requirement for production has been a detriment for development. So organic cells were introduced for their easy and cheap fabrication but have struggled to catch up to the efficiencies of inorganic cells. Recently, a class of hybrid organic-inorganic materials called Perovskites have been found to show excellent potential for photovoltaic performance and cheap production. In this project we will simulate and study solar cell structures containing Perovskites as the active material in Sentaurus TCAD. First, the material file for Perovskites will be created as it is not available in the standard Sentaurus material library. Then, the file will be calibrated and will be followed by electrical simulation. Finally the I-V curves for the respective structures will be extracted and a detailed study of their performance will be provided.

Economics of Photovoltaic Systems

Gavin McCormick

The adoption of photovoltaic (PV) systems has surged in recent years, driven by a combination of technological advancements, government incentives, and declining costs. This paper provides a comprehensive examination of the economics of PV systems, focusing on key aspects that have shaped their evolution over the past decade.

First, the paper analyzes the remarkable price trends of PV systems, shedding light on the consistent and significant cost reductions observed in the industry. The decline in PV system prices has been a pivotal factor in making solar energy increasingly accessible to consumers.

Government incentives have played a pivotal role in propelling the PV industry forward. The study explores various incentive programs at federal, state, and local levels, showcasing how they have incentivized investment in solar energy infrastructure. Special emphasis is given to tax credits, feed-in tariffs, and net metering policies, which have provided essential economic support for PV system installations.

The paper concludes with a detailed comparative analysis of the return on investment (ROI) for PV systems in two distinct locations: Dayton, Ohio, and Auburn, Alabama. This granular examination takes into account regional climate variations, utility rates, and local incentives, allowing for a comprehensive assessment of the financial viability of solar installations in different contexts. In summary, this paper offers a thorough exploration of the economics of PV

systems, considering price trends, advancements, government incentives, and ROI analysis. By investigating these facets, it provides a comprehensive overview of the economic forces driving the solar energy industry's growth and showcases the economic viability of photovoltaic systems in specific geographical locations. This research serves as a valuable resource for policymakers, investors, and consumers alike, seeking to make informed decisions regarding the adoption of solar energy solutions.

Predictive Maintenance Mechanisms for Photovoltaic Systems

Wesley O'Quinn

As the usage of Solar Photovoltaics for commercial power generation continues to see widespread adoption, the reliability of its associated power factor continues to grow in importance. With its growing share of the electrical generation portfolio, unplanned outages can have significant ramifications. The ability to decrease costly unplanned outages is enabled by Digital Twin/Industrial Internet of Things (IIOT) Technology and Artificial Intelligence Predictive Maintenance Techniques. This research sought to provide a literature review of current State of the Art (SOTA), open problems in the field, and relevant data sets to enable further research. A significant number of papers were reviewed with techniques ranging from LSTM Networks to simplistic Artificial Neural Networks (ANN). Multiple open problems--such as granular prediction frameworks--were identified. Finally, various datasets were identified including somewhat detailed condition monitoring type repositories. The hope is that this review will enable further research in the field.