

IET travel winner: Mac Geoffrey Ajaereh (PhD student at AAPS CDT, University of Bath)

Title: Unlocking Insights in Battery Characterisation: My Research Visit with the Argüelles Lab at Penn State University

Information:

In the realm of energy storage and electric vehicles (EVs), the characterisations of lithium-ion batteries are of paramount importance. These batteries serve as the lifeblood of EVs, impacting their performance, efficiency, and safety. My journey into this vital research endeavor began with a profound understanding of the significance of Ultrasound Non-Destructive Evaluation (NDE) in assessing the State of Charge (SoC) of these batteries. Seeking to advance this area of research and enrich my academic experience, I embarked on a transformative research visit at Penn State University, where I had the privilege of collaborating with the distinguished Argüelles Lab. The Argüelles Lab, under the leadership of Dr. Andrea P. Argüelles, has gained recognition for its pioneering work in ultrasound applications for non-destructive material characterisation. Their innovative approach, encompassing multiple length scales and stages of the manufacturing process, aligns perfectly with my research objectives.

The primary focus of this research visit was to explore the capabilities of ultrasound NDE in characterising lithium-ion batteries' SoC, particularly in the context of automotive applications. Traditional methods often posed risks to battery integrity, making ultrasound NDE an attractive alternative due to its non-invasive and real-time assessment capabilities. This visit also aimed to harness spatial mapping techniques, reporting wave speed and attenuation across batteries. These techniques held the potential to establish a robust correlation between ultrasound-derived metrics and battery SoC, providing valuable insights into battery health and performance. The overarching goal was to contribute to the development of safer, more efficient, and longer-lasting batteries for EVs and other applications.

My involvement in this research visit was both exciting and educational. It offered me a unique opportunity to collaborate with experts in the field and gain hands-on experience with cutting-edge technology. Throughout the visit, I actively engaged in research activities alongside the Argüelles Lab team, contributing to experiments, data collection, and analysis. I also had the privilege of participating in discussions and knowledge-sharing sessions, where ideas flowed freely, and perspectives were exchanged. These interactions deepened my understanding of ultrasound NDE and its potential applications in battery characterisation. During my time at Penn State University, I had the honour of running experiments that focused on the innovative spatial mapping techniques we employed to correlate ultrasound metrics with battery SoC. The team included fellow students and researchers, faculty members and collaborators at Penn State, creating a stimulating environment for exploration, discussion and feedback.

In addition to meticulous testings, I also engaged in informal discussions with my peers and mentors. These interactions allowed me to refine my research ideas, address challenges, and gain valuable insights from experts in the field. One of the most enriching aspects of this research visit was the networking opportunities it provided. Collaborating with the Argüelles Lab and Penn State University's research community allowed me to establish connections with like-minded researchers and professionals. These connections extended beyond the confines of the laboratory, fostering long-lasting relationships and potential avenues for future collaborations.

I also had the privilege of attending various events and activities outside the academic setting. These included social gatherings, sports events, and even the celebration of the 4th of July, a cherished American tradition. These experiences not only enhanced my cultural understanding but also strengthened the bonds of friendship with my colleagues at Penn State. In addition to our collaborative research efforts, I had the opportunity to embark on technical and academic visits that complemented our work. These visits included interactions with the Kube Lab and the BATTERY Lab at Penn State, both of which played a pivotal role in advancing our research goals. Collaborating with these esteemed research groups allowed us to broaden our experimental scope and validate our findings.

We delved into post-process inspection of ready-for-service components, multi-scale characterisations, process-structure-property relationships, and inspectability considerations. These visits expanded our knowledge base and provided us with valuable insights into the practical implications of our research in real-world applications. This research visit has been nothing short of transformative in shaping my academic and research journey. It has not only enriched my understanding of ultrasound NDE and its applications in battery characterisation but has also broadened my horizons by exposing me to the collaborative spirit of international research. Through this visit, I have contributed to pioneering work that holds the promise of safer, more efficient, and longer-lasting lithium-ion batteries. Our exploration of spatial mapping techniques has opened new avenues for assessing battery health and SoC, with potential implications for a wide range of industries beyond automotive.

Moreover, the visit has allowed me to establish enduring connections with experts in the field, fostering a global network of colleagues who share my passion for advancing sustainable energy solutions. The insights gained, the experiences lived, and the relationships formed during this visit will undoubtedly leave an indelible mark on my academic and professional journey. Hence, my research visit to Penn State University's Argüelles Lab has been a remarkable chapter in my academic career. It has fortified my commitment to pushing the boundaries of knowledge and innovation in the realm of energy storage. As I continue my research endeavours, I carry with me the invaluable experiences and lessons learned from this transformative visit, propelling me towards a future where safer, more efficient batteries are a reality.

This transformative research visit to Penn State University's Argüelles Lab, with its profound impact on advancing battery characterisation and fostering international research collaborations, owes its existence to the invaluable support of the IET travel grant. Without this grant's financial assistance and recognition of the research's potential, this visit would have remained an unrealised aspiration. The grant's pivotal role in facilitating knowledge exchange, technical exploration, and the establishment of enduring connections underscores its significance in bringing this academic endeavour to life, ultimately contributing to the advancement of sustainable energy solutions.