

IET International Travel Award Report 2024

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I received an IET International Travel Award in May 2024 to attend the Gordon Research Conference (GRC) on 'Unconventional Semiconductors' in Easton, Massachusetts, USA from 15-21 June 2024. GRCs are extremely prestigious events in the Natural Sciences that not only focus on high-quality scientific presentations but also put equal emphasis on fostering interactions within close-knit research communities with a very strong subject focus. They also feature highly selective participation (~150 attendees this year) of scientists at different stages of their academic/industrial careers. These conferences are held in a very distinctive style in a typically remote location where extensive networking through informal interactions is heavily encouraged through day-long sessions along with community dining and free afternoons for planned group activities. Quite uniquely, the GRC also mandates the presentation of pre-publication research which offers a first-hand glimpse into the absolute frontiers of the field through the various invited talks and posters.

The GRC on Unconventional Semiconductors is primarily based on novel material discovery, synthesis, device fabrication and advanced characterization of metal halide perovskite materials. These are a new class of semiconductors that have, in the last decade, revolutionized the field of affordable and accessible high-performance optoelectronics. They are endowed with excellent optoelectronic properties that make them optimum candidates for a range of device needs such as solar cells, light emitting diodes (LEDs), lasers, transistors, radiation detectors and sensors among many others. This field has thus emerged as one of the most timely, exciting and promising routes for sustainable harnessing and utilization of renewable energy. This is especially relevant in the current times where all nations of the world are racing towards a Net Zero future.

The GRC only accepts posters as contributed presentations and I was very fortunate to have a poster accepted at this conference. I presented my work on 'dimethylammonium-incorporated all-inorganic perovskite nanocrystals for red LEDs'.

All-inorganic perovskite nanocrystals (NCs) are attractive candidates for light emission applications. Of these, cesium lead iodide (CsPbI₃) NCs have been shown to be promising but their device application is still inhibited by their inherent ambient phase instability at room temperature. With the addition of bromine (Br), structural stability can be attained and CsPbI_xBr_{3-x} NCs are formed with ideal bandgaps for emission within the Rec 2020 colour gamut. In contrast with pure-iodide compositions that require high temperature-based (hot injection) processes to form the perovskite phase, mixed-halide NCs afford facile synthesis through room-temperature ligand assisted reprecipitation (LARP). However, these materials are still plagued by phase separation under optical or electrical excitations of intensities typical in a working device.

In this work, we alloy the A-site of pure-red emitting CsPbl₂Br with dimethylammonium (DMA) to improve its phase stability under excitation while retaining high photoluminescence quantum yields. To our knowledge, this is the first study of DMA-alloying in perovskite NCs through facile LARP synthesis techniques. We propose a novel synthetic route at room temperature and then study the crystal structure and morphology as a function of different DMA contents through an interplay of crystallographic and optical data. We further probe the crystal lattice through solid-state NMR and high-resolution STEM-EDX to understand the mechanism and extent of DMA incorporation. We also use X-ray photoelectron spectroscopy (XPS) to investigate the DMA-contents. Finally, we fabricate LEDs using these materials and show improved brightness, efficiency and operational stability in DMA-incorporated NC-based devices as compared to the pristine reference samples.

Due to the poster sessions being planned around communal dining times, all attendees were able to experience very good traffic on their posters with extensive discussions and exchange of ideas. I was able to interact with an expert in spectroscopic characterization to plan some further experiments for this project which would undoubtedly add value to the findings. I was also able to start a new collaboration with a research group in my field based at the University of Washington, Seattle where I am currently sending samples for studies. It was thus, very productive and rewarding to present my work before such a specialized audience.

An associated Gordon research seminar (GRS) was held in the weekend immediately preceding the GRC, as is the norm for most GRCs. These seminars are largely geared towards early career researchers who benefit immensely not just from the exchange of scientific ideas but also a host of networking opportunities. I also presented a poster at the GRS. The seminar featured a great series of oral presentations and concluded with a Careers Panel where eminent scientists from both academic and industrial research organizations discussed their careers in great detail and outlined the similarities and differences in the nature of research in these two spaces. This was quite helpful for early career scientists like myself since such first-hand experiences afford specialized information that is not otherwise available in the public domain.

I had been selected as a Discussion Leader (equivalent to Session Chair) for the GRS session on 'Synthetic Strategies and Struggles' which opened up an exciting opportunity for me to network closely with the entire GRS cohort. At the end of the GRS, I was encouraged to run for the position of Chair (with a running mate for co-chair) for the next version of GRS on Unconventional Semiconductors (to be held in 2026). We were elected winners by a majority and are thrilled to be able to co-chair the next GRS. This would be a brilliant learning opportunity and an excellent addition to my academic career. In this role, I would be working very closely with the chairs of the next GRC as well, to plan and organize the entirety of GRC/GRS 2026. Not only would this present me with abundant networking opportunities but also help me develop my communication and organizational skills to a large extent.

In conclusion, attending the GRC/GRS meeting has been an enormously valuable experience for me and I am very thankful for the kind support of IET in enabling this. I look forward to more such opportunities in the coming times.



1. University of Oxford team at the GRC



2. Presenting my poster at the GRC