明治大学外国人研究者招聘制度　報告書

＜招聘教授・研究員の情報 / Guest Professor・Guest Scholar＞

氏　名 Name	Girish Kakkepalya Hanumantharaju
所属機関(派遣元) Affiliation (Home Organization)	University of Augsburg
現在の職名 Position	Ph D student
招聘期間（日本への入国日から出国日） Invitation Period (from the date of entry to departure)	2025.6.16-2025.8.26
専攻 Field of Research	Institute of Physics
ホスト教員氏名と所属学部研究科等 Name of host teacher and affiliation at Meiji University	Yutaka Noguchi, School of Science and Technology

＜外国人研究者からの報告 / Foreign Researcher Report＞

①研究課題　/　Research Theme

Investigating exciton quenching in perovskite nanocrystal thin films

②研究概要　/　Outline of Research

Perovskite nanocrystals (PNCs) have gained significant interest in the research community for light-emitting applications due to their exceptional optical properties. Factors such as charge-carrier balance and type of ligand passivation on the nanocrystal surface play a crucial role in determining the electrical and optical stability of PNCs and the overall device efficiency. Additionally, vapor deposited polar organic thin films, typically the electron transport layers (ETLs), show preferential alignment of their permanent dipole moment (PDM), leading to a macroscopic polarization of the film (Fig.1(a)). This results in something called giant surface potential (GSP), which leads to charge accumulation at the thin film interfaces and can significantly influence the charge carrier dynamics in perovskite nanocrystal LEDs (Fig.1(b)). This effect is quite well reported in organic LEDs, where the charge accumulation would confine the emission zone and act as an exciton quencher, leading to faster device degradation. However, studies on the effect of GSP on perovskite nanocrystal LEDs are scarce. Addressing this, my current research focuses on understanding the charge accumulation behaviour due to GSP and the corresponding exciton quenching in perovskite nanocrystal LEDs. One suitable technique to understand both the charge dynamics and the exciton behaviour in the device is through the displacement current measurement (DCM) technique combined with simultaneous observation of the photoluminescence (PL) intensity. This technique, developed by Prof. Noguchi's group, is analogous to the conventional capacitance-voltage measurement but is a faster technique for investigating the effect of GSP in perovskite nanocrystal devices.

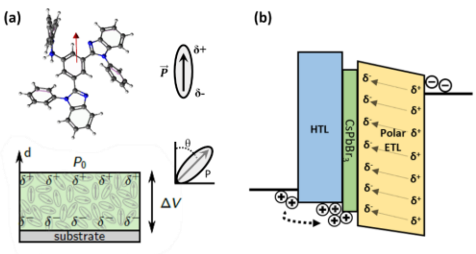

Figure 1. (a) Macroscopic polarization of vapor deposited organic thin film due to the net orientation of the molecules PDM. (b) Charge accumulation in perovskite nanocrystal LED due to GSP of ETL.

③招聘期間中の研究活動の実績　/　The research results as Guest Professor・Guest Scholar

Perovskite nanocrystal LEDs were fabricated at Noguchi Laboratory, Meiji University. Displacement current measurements were performed while simultaneously monitoring the PL intensity. The results, presented in Fig. 2, indicate that the incorporation of TPBi ETL having GSP reduces the PL quenching in perovskite LEDs. These observations are consistent with previous supporting measurements conducted at Augsburg. Unlike in OLEDs, where GSP-induced charge accumulation typically increases PL quenching, the presence of GSP in perovskite LEDs appears to mitigate non-radiative recombination, thereby enhancing their optical performance. This suggests that GSP could be a beneficial design strategy for improving the efficiency and longevity of perovskite-based LEDs.

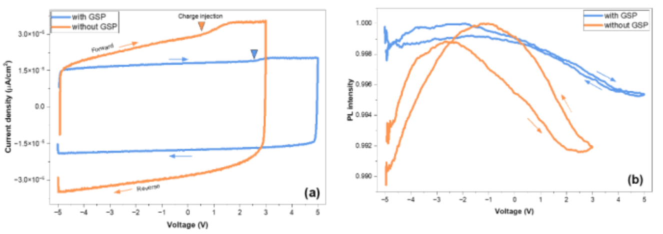

Figure 2. (a) DCM & (b) PL intensity plots of perovskite LEDs with two ETLs.