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Femtochemistry, Nanotechnology, Next-generation Solar Cells

We are "Solar Photovoltaic Research Laboratory" of Applied Chemistry Department, NCTU. Our primary research interest is to develop and characterize potential energy materials such as organo-inorganic hybrid metal halide perovskites (**Figure 1**) for solar cell applications. **Perovskite solar cells** have emerged to be one of the best candidates for next-generation solar cells because of their rapid improvement on device performance to attain PCE exceeding 20 %. However, this material contains lead element that must be replaced before commercialization. Moreover, the performance enduring stability is the problem to be resolved due to its affinity to humidity. To solve these problems, we are working on novel **lead-free perovskite** materials in a **carbon-based device** configuration free of organic hole conductor layers (**Figure2**). Furthermore, varied types of solar cells in either *n-i-p* or *p-i-n* architecture with either mesoscopic or planar perovskite active layer (**Figure 3**) are under investigations in our laboratory. We are also investigating **charge transport kinetics** of perovskite materials with varied crystal morphologies and in contact with different charge extraction layers using femtosecond photoluminescence (**Figure 4**) and transient absorption techniques. The carrier and exciton relaxation model can be established (**Figure 5**) based on our real-time observations. **Key Facilities:** Femtosecond optical gating (FOG), Time-correlated single-photon counting (TCSPC), Femtosecond and nanosecond transient absorption (TA), Photo-induced absorption (PIA), Electrochemical impedance spectroscopy (EIS), Transient photocurrent and photovotage decays, IV/IPCE characterizations.

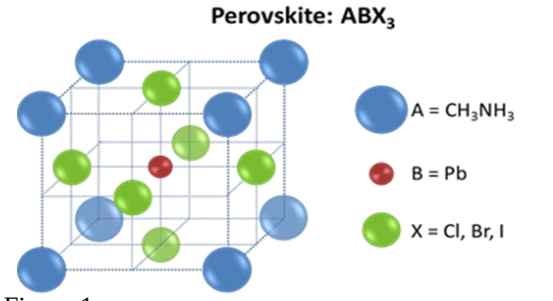

Figure 1

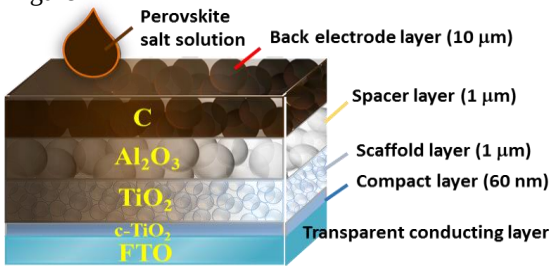

Figure 2

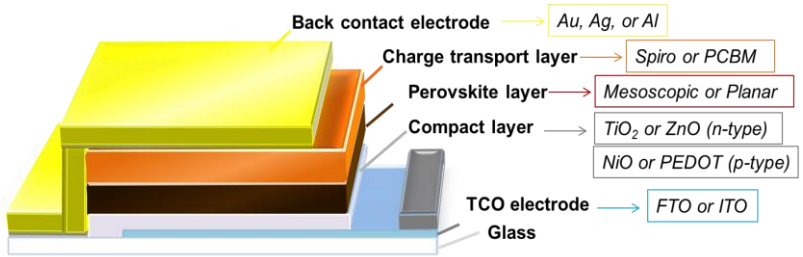

Figure 3

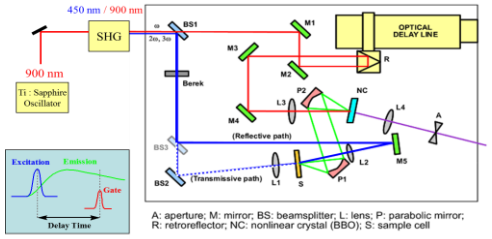

Figure 4

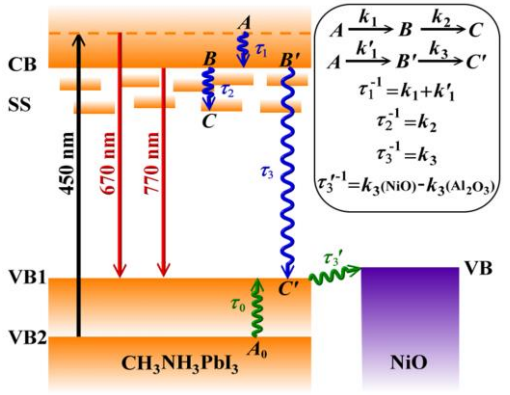

Figure 5