This report features the work of Bing-Ming Cheng and his co-workers published in Angew. Chem. Int. Ed. ***56****, 14469 (2017).*

TLS 03A1 BM – (HF-CGM) – Photoabsorption/Photoluminescence

- VUV photoluminescence
- Astrophysics, Astrochemistry

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Formation of Wannier-Mott Excitons in Solid Carbon Oxide

The spectral shift of the electronic transitions of solid carbon oxide nano-thin film upon change of deposition temperatures results from the formation of the spontelectric field and the presence of Wannier-Mott excitons.

Photoexcitation of insulators and semiconductors may generate electron-hole pairs, rather than free charge carriers. The electron-hole pairs, also called excitons, are attracted to each other by the electrostatic Coulomb force. Now this phenomenon has been found in very diverse materials, including liquids, polymer-fullerene heterojunctions, and inorganic-organic hybrid materials. Excitons may be classified into two major categories based on the properties of the generated excitons in materials. If the generated excitons are entirely located on the same molecule, it is a Frenkel exciton which has a binding energy in the region 0.1–1 eV. Frenkel excitons are usually found in materials with a small dielectric constant. A Wannier-Mott exciton is the second category of exciton. It is usually found in materials with a large dielectric constant and a low band gap. Yu-Jung Chen (National Central University) and his co-workers[1] reported the presence of the Wannier-Mott exciton in solid CO, which is a material with opposite properties (high band gap and low dielectric constant), by observing the strong temperature dependence of the spontelectric nature of solid CO.

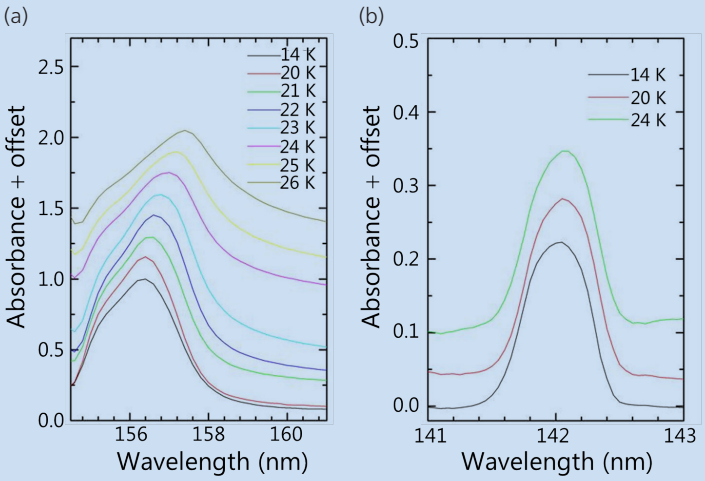

Fig. 1: VUV absorption spectra of (a) solid CO and (b) solid N_2 at various deposition temperatures. [Reproduced from Ref. 1]

The measurements of vacuum ultraviolet (VUV) absorption spectra of various pure molecular icy samples with a thickness in the nanoscale were performed at **TLS 03A1**. These icy samples included CO, N_2O, N_2, and CO_2. The former two species are dipolar and possess a spontelectric behavior, whereas the latter two has no dipole moment and shows no such spontelectric behavior. **Figure 1(a)** shows VUV absorption spectra of solid CO in the (0,0) band of the $A\,^1\Pi \leftarrow X\,^1\Sigma$ transition at various deposition temperatures. Spectra of solid N_2 under similar conditions are shown in **Fig. 1(b)** for comparison. A change of a few degrees K in deposition temperature can shift the electronic absorption band of solid CO by several hundred wavenumbers. This observation of band shifts as a function of a deposition temperature results from the spontelectric effect associated with the nature of the molecular disorder. However, this spon-

telectric effect observed in solid CO may arise from four mechanisms: (1) the permanent dipole moment changes and the associated stark shift between the *X* and *A* states; (2) the induced dipole change through polarizability difference between two states; (3) the change in degree of dipole orientation associated to the change in deposition temperatures; (4) electron-hole formation in the excited state of solid CO. Chen *et al*., reported the observation of Davydov splitting of solid CO that arose from a force field of CO lattice with cubic symmetry and supports the formation of electron-hole pairs in the excited state of solid CO. This crystal field results in the separation of the energy levels of the exciton into three components. They proposed a simple electrostatic model to describe how the spontelectric effect affects the separations of Davydov splitting. The experimental and theoretical results are in a good agreement on the spectral shifts along with various deposition temperatures. In contrast, solid nitrogen having no spontelectric field, shows no dependence between Davydov splitting and deposition temperature. This work explains the long-standing mystery for the sensitivity of the VUV spectra of the molecular solids on the various deposition temperatures correlating the formation of the Wannie-Mott excitons. (Reported by Yu-Jong Wu)

This report features the work of Yu-Jung Chen and his co-workers published in Phys. Rev. Lett. ***119****, 157703 (2017).*

TLS 03A1 BM – (HF-CGM) – Photoabsorption/ Photoluminescence

- VUV Absorption
- Molecular Science

Reference

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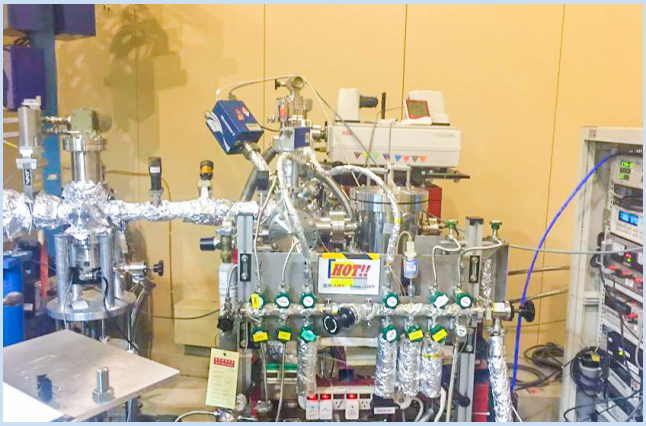

The Interstellar Photoprocessing System (IPS) connected to the **TLS 03A1** beamline.

Ultra-Bright Near-IR OLED

The Pt(II) complex-based OLEDs emitting at 740 nm possess very high efficiency and radiance. The external quantum efficiency can reach 24% in a normal planar structure.

Advances of light-emitting diodes (LEDs) since their discovery in the 60's have changed the way we light up our daily lives in the past decade. Amongst these advances is the development of electroluminescent material of the emissive layer, composed of organic compounds and called organic LEDs (OLEDs). Compared to the LEDs, the OLEDs possess many advantages for producing displays and/or lighting luminaires including their thin profile, flexible, wide view angle, high contrast and color gamut. Due to the technological needs of flat panel displays that are common in our daily life, the efficiency and radiance of OLEDs emitting in the visible light spectrum has matured rapidly in recent years. In contrast, the development of OLEDs emitting in the near-IR (NIR) is just beginning. The function of NIR emitters has a great importance for applications in optical signal processing, night vision technologies, bioimaging, photodynamic therapy, and so on.[1] However intrinsic quenching mechanisms via nonradiative processes limits the efficiency for NIR emissions of phosphors. If the energy between the electronic excited states and the ground state is close, particularly when the energy gap lies in the NIR region, the nonradiative process would be greatly enhanced through the coupling of vibrations in the two states; this is commonly called "energy gap law". Therefore, the best reported external quantum efficiency (EQE) of NIR OLEDs is lower than 14.5%.