Introduction to function & booking of XPS/UPS/2PPE facility

1. General Information of the facility

Two-photon photoemission spectroscopy (2PPE) is a powerful experimental technique used to study the electronic structure and dynamics of solid or liquid surfaces. It involves the absorption of two photons by a material, which results in the emission of an electron.

The process is divided into two steps. First, a photon excites an electron from a filled state to an unoccupied state above the Fermi level. This is followed by the absorption of a second photon that gives the electron enough energy to overcome the work function of the material and leave the surface.

2PPE provides information about the energy and momentum of the emitted electrons, which can be used to determine the electronic structure of the material. It can also measure the lifetime of excited states, providing insight into the dynamics of electron relaxation processes.

Since 2PPE is a surface-sensitive technique, it's particularly useful in the study of thin films, surface adsorbates, and interface states. It also allows for the study of phenomena such as surface plasmons and quantum well states.

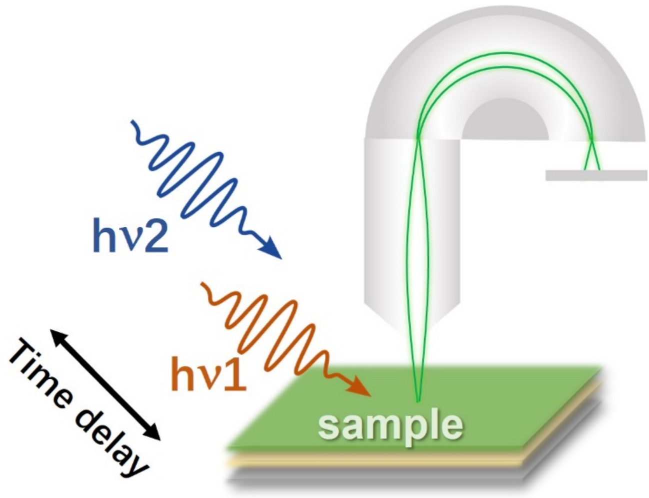

Figure 1. Experimental process of 2PPE. First, a lower energy pump pulse is focused onto the sample. After a specific time delay, the second higher energy probe pulse is shed onto the sample.

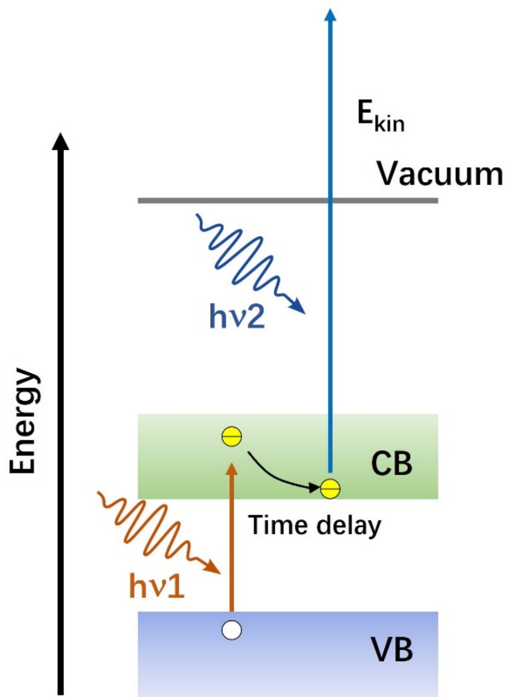

Figure 2. Electron dynamics in 2PPE process. A lower energy photon ‘pumps’ an electron in valance band or the highest occupied molecular orbital (HOMO) into conduction band or the lowest unoccupied molecular orbital (LUMO). After the time delay, a second higher energy photon then ‘probes’ this electron further above the vacuum level. The final kinetic energy of the electron (Ekin) is measured by a hemispherical electron energy analyzer.

2. Technical parameters

Base vacuum: 5×10^{-10} mbar
Pump pulse wavelength range: 650~850 nm
Probe pulse wavelength range: 250~370 nm
Sample stage temperature: 15 K ~ 450 K
Delay time resolution: 20 fs

The 2PPE setup is combined with ultraviolet photoemission spectroscopy (UPS) and x-ray photoemission spectroscopy (XPS), which can in-situ characterize the electronic structure of the sample. The sample can be cleaned with Ar ion sputtering before measurement.

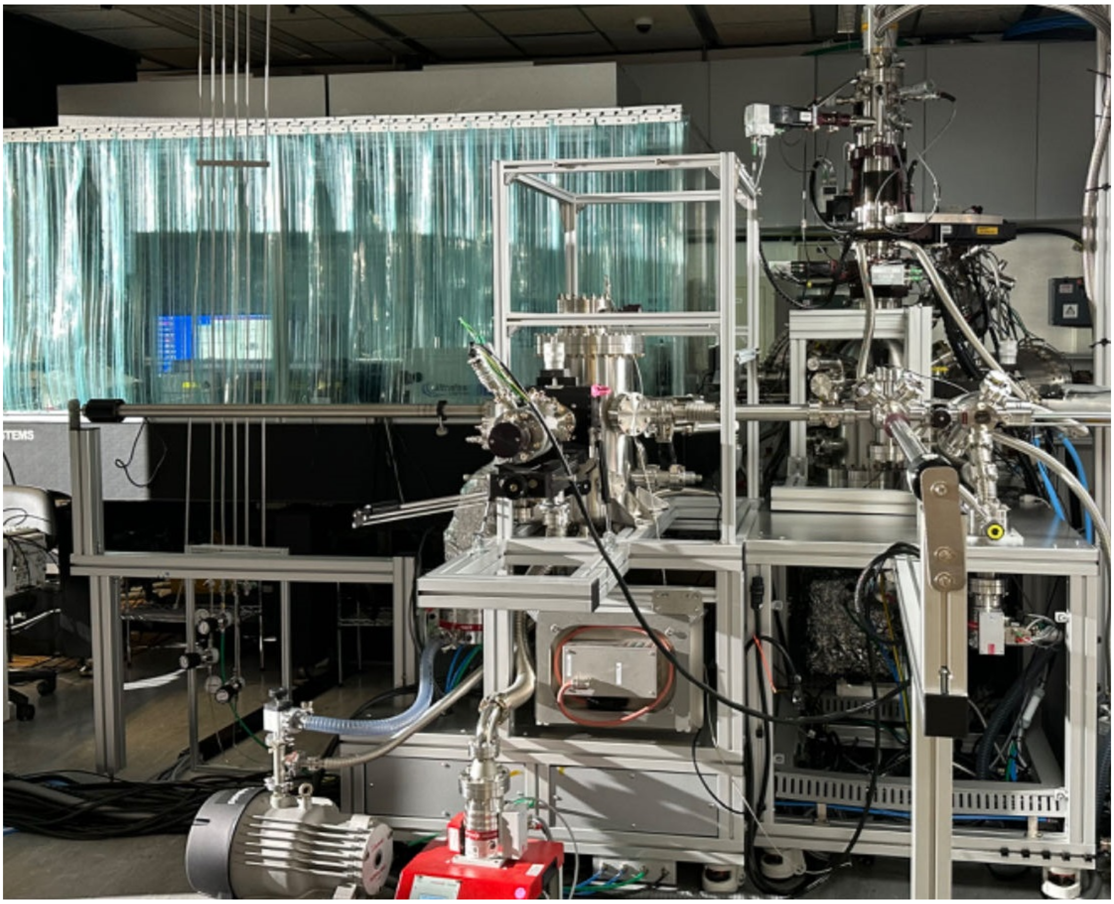

Figure 3. 2PPE setup, combining UPS and XPS equipment together.

3. Measurement examples

Figure 4 shows 2PPE results of a typical organic semiconductor of pentacene thin film. Figure 4a is a pseudo-color representation of the 2PPE spectra. The initially generated signal at energy of 1.64 eV in time zero is the singlet (S_1) state of pentacene. A lower-energy signal (~0.85 eV) appearing after very short time can be attributed to triplet (T_1) state. Figure 4b shows the kinetics of these two excited states. After excitation, the S_1 state fast decays with a lifetime around 100 fs, followed by the rise of T_1 state in a similar timescale, revealing the intersystem crossing phenomenon of pentacene.

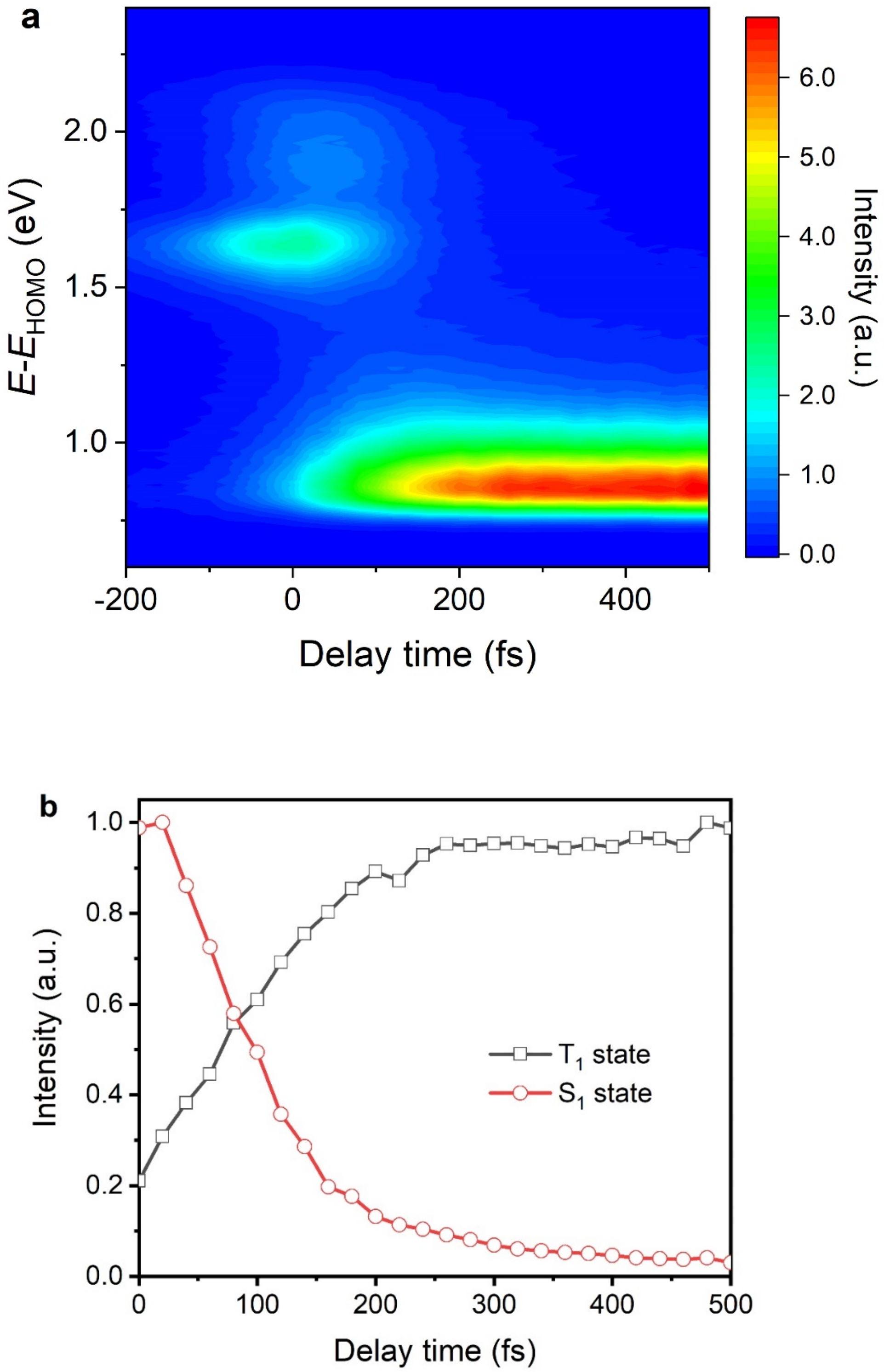

Figure 4. Typical 2PPE results of pentacene thin film sample. After pumping, a S_1 state with energy of 1.6 eV initially generates. In very fast timescale, a triple state signal at ~0.8 eV was observed, followed by the decay of S_1 state.

4. Booking system

To access the facility, users need to book an experiment via two steps:

(1) First, users need to fill in and submit a form via scan a QR code (Figure 5). The submitted information (Figure 6) will be sent to the administrator.

(2) Upon confirmation that the samples are UHV compatible, the administrator will enable the users' access for a specific Google calendar (Figure 7) for booking a time slot. If the samples or experiments are not compatible to the system, the administrator will advise the user on how to modify the samples or experiments.

Figure 5. Booking QR code


2PPE booking system

2PPE booking system

Fill the information for use of 2PPE system

登录 Google 即可保存进度。了解详情

* 表示必填

姓名/Name *

您的回答

日期 /Date *

年 月 日

/ /

联系方式/Contact (Email or telephone) *

您的回答

Supervisor *

您的回答

Sample type *

您的回答

Operation time *

- [ ] a.m.
- [ ] p.m.

System condition after use *

您的回答

提交

清除表单内容

Figure 6. Submitting information

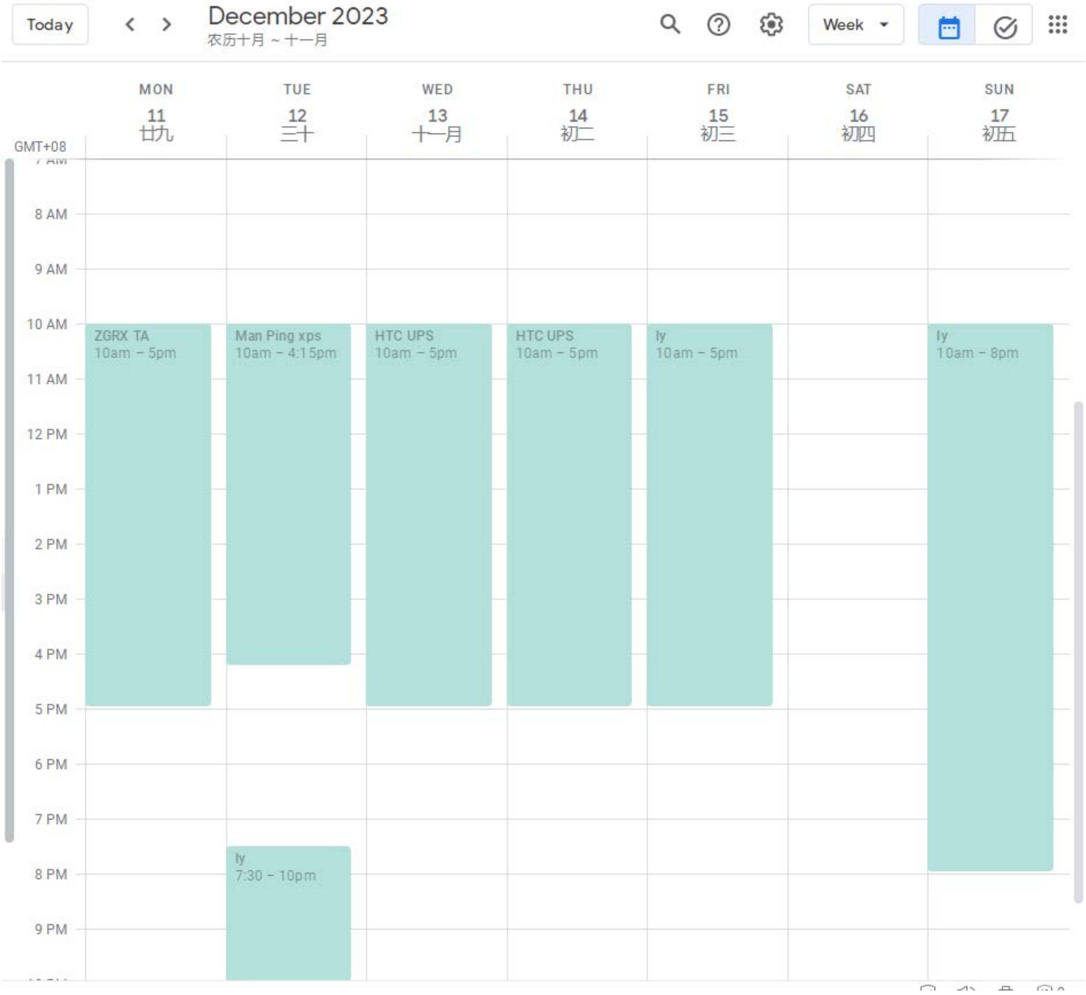

Figure 7. Booking Google calendar system

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