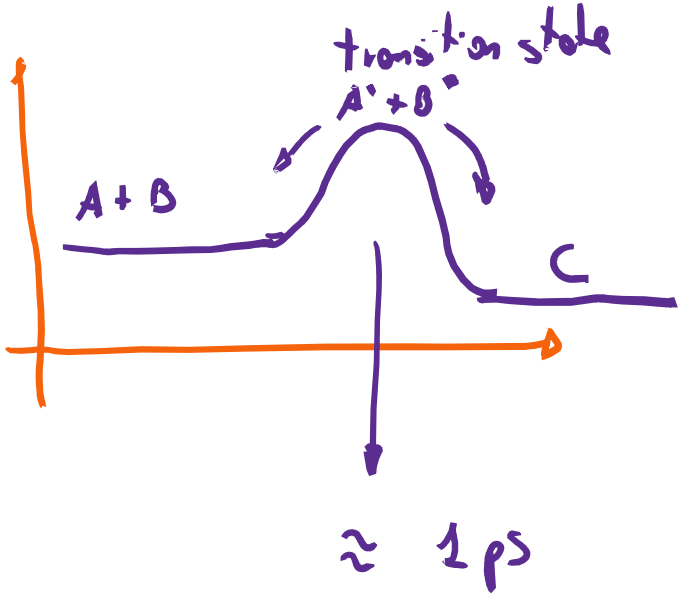
Misure di dinamiche elettroniche

Introduzione a spettroscopie Pump & Probe

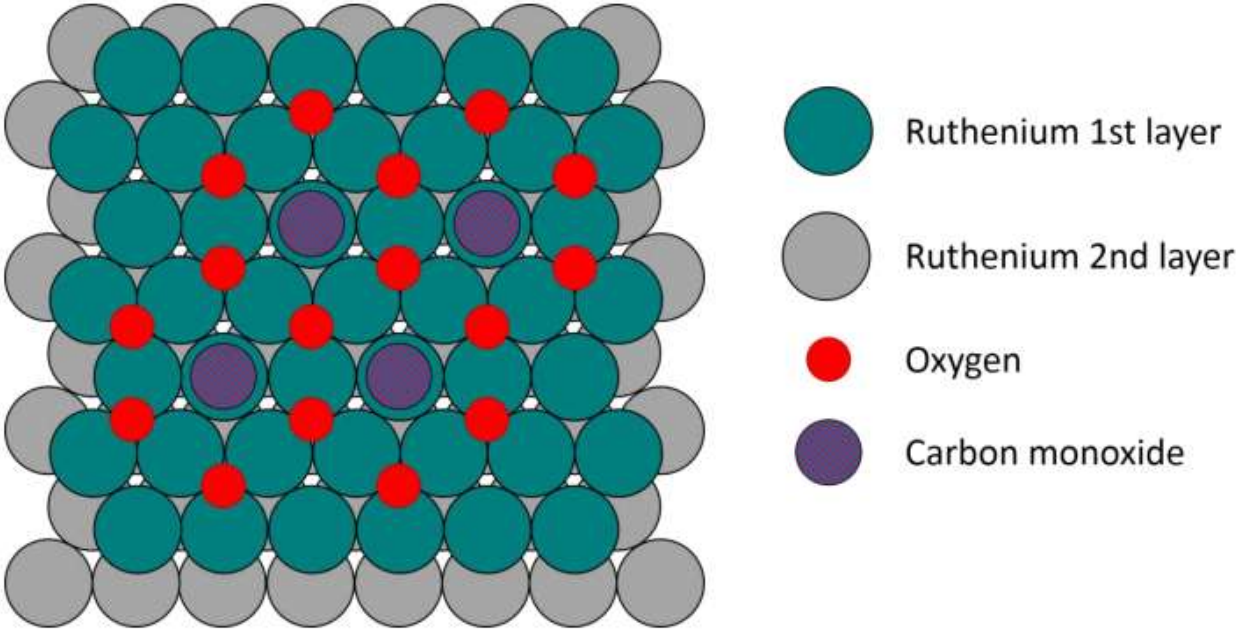


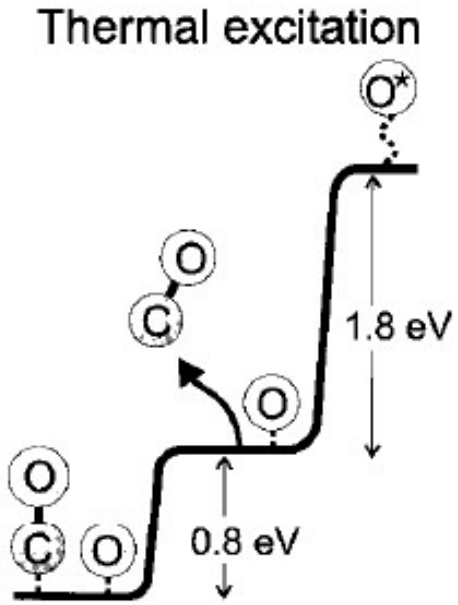
≈ 1 ps

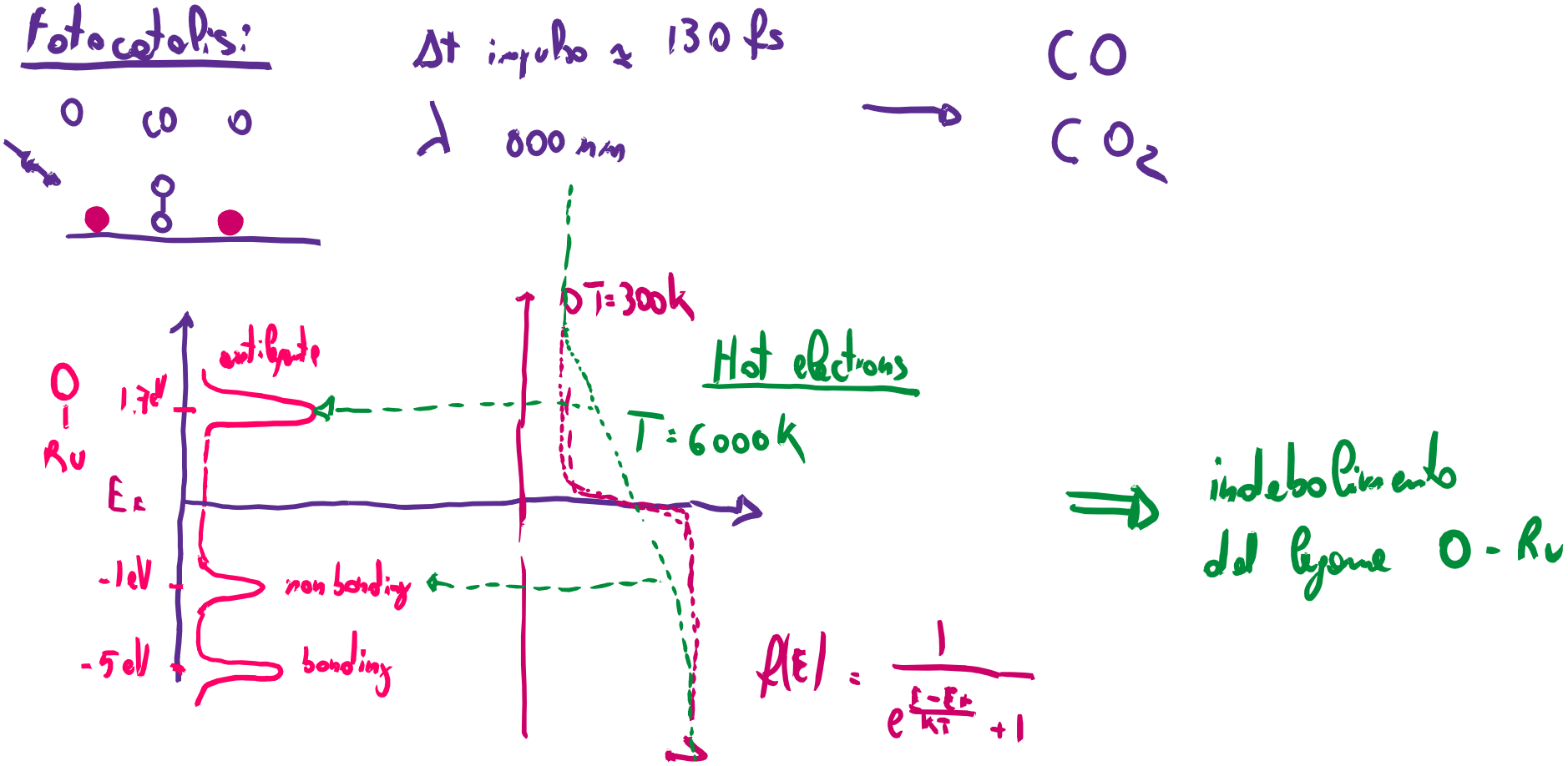
Ossidazione di CO su Ru

- O_2 dissocia spontaneamente
- CO si lega
- Se scaldo…CO se ne va prima che l'ossidazione avvenga

Ru(100)

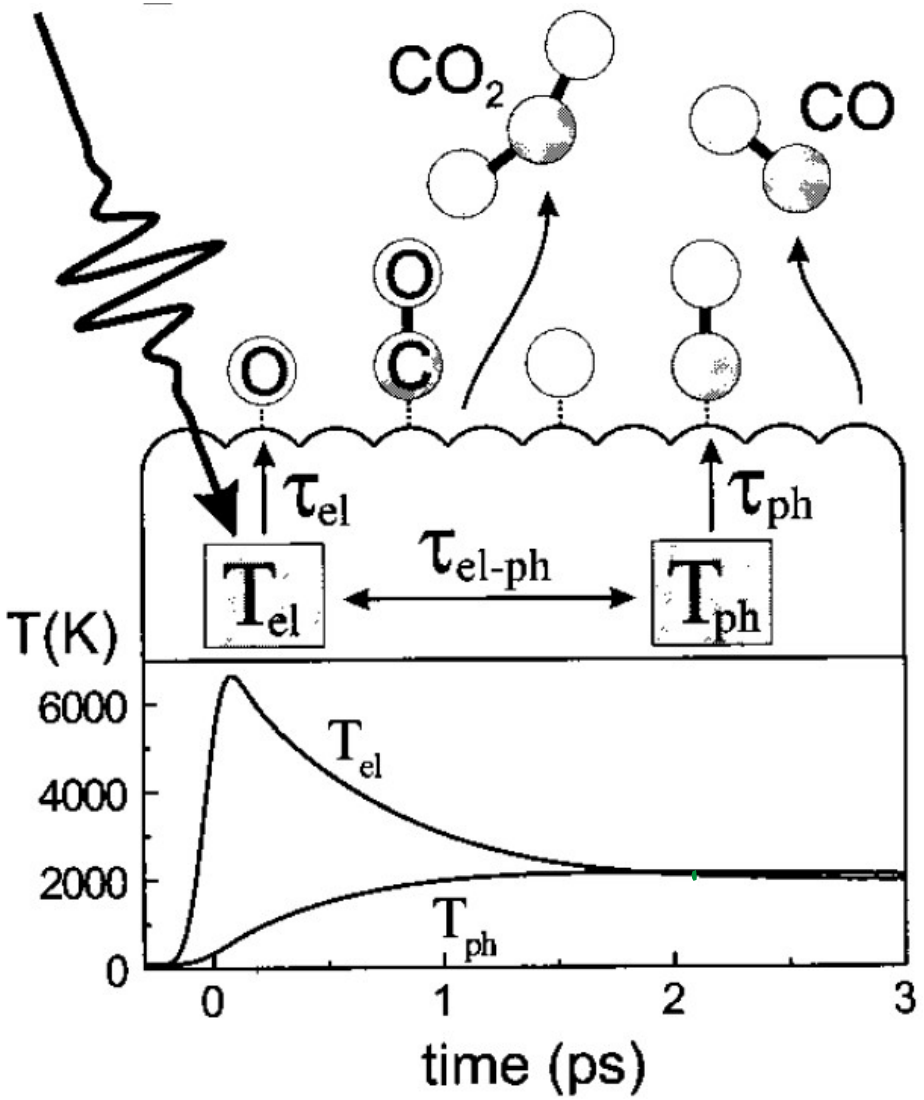


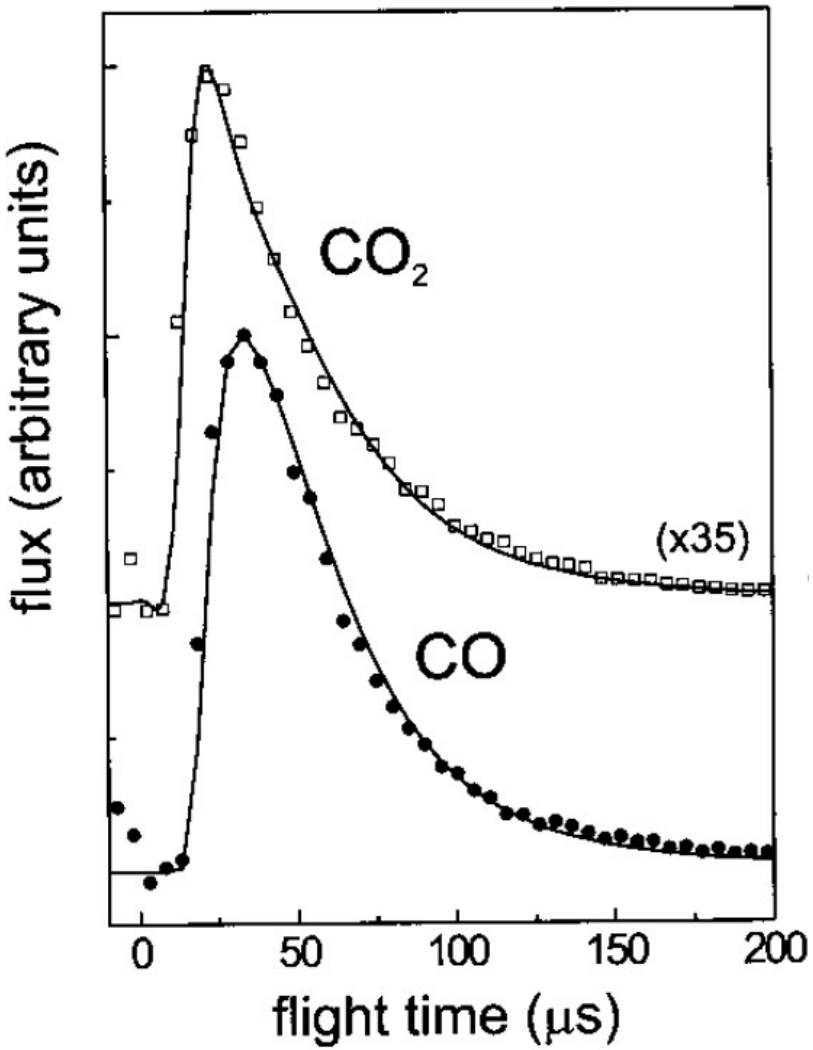




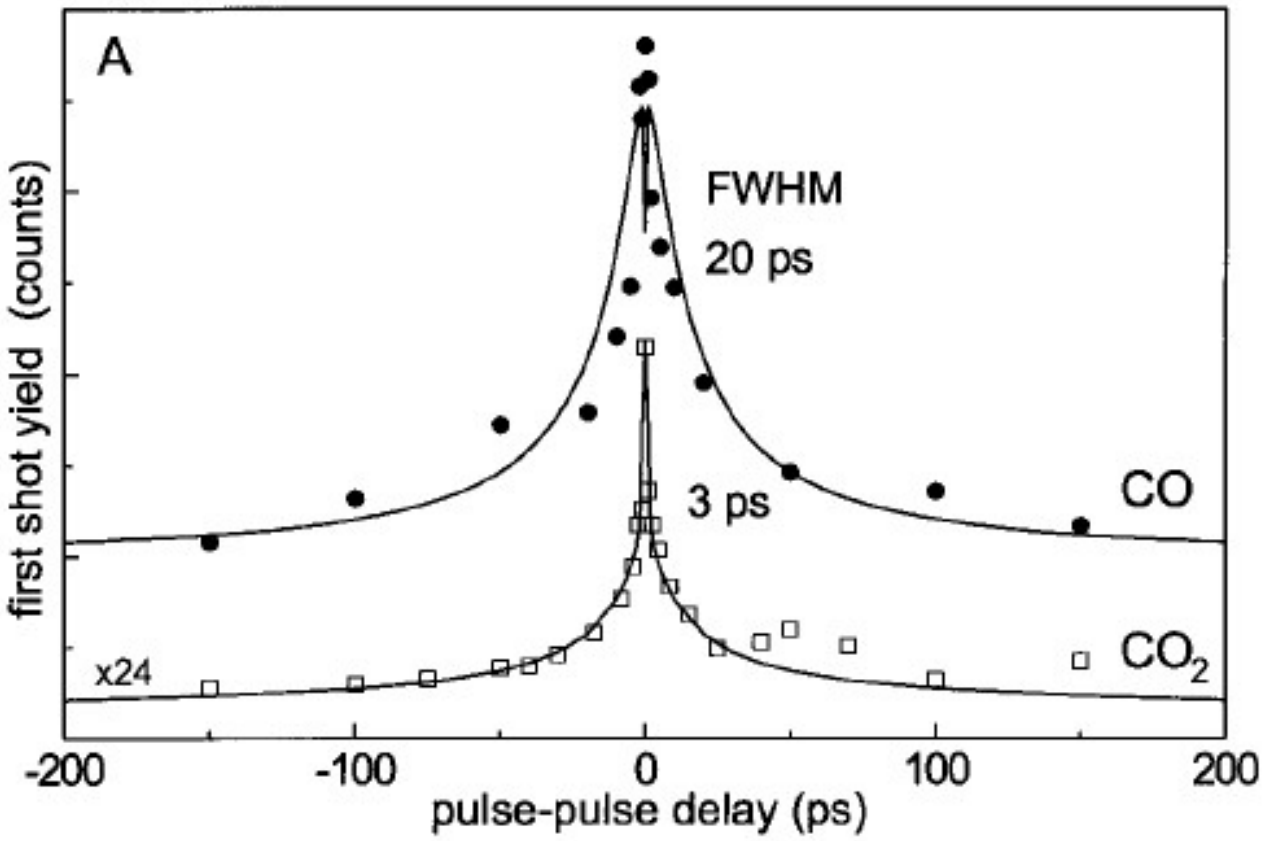
Lo stato antilegante viene parzialmente riempito con un impulso di fotoni e la relativa Te=6000K. Lo stesso impulso provoca un parziale svuotamento del primo orbitale occupato, che però ha carattere non legante.
Complessivamente, l'impulso di fotoni indebolisce il legame O-Ru e mette l'ossigeno in uno stato attivo per l'ossidazione di CO che gli sta accanto

13 AUGUST 1999 VOL 285 SCIENCE www.sciencemag.org


CO2
CO
O
C
O
τel
τph
τel-ph
Tel
Tph
T(K)
6000
4000
2000
0
Tel
Tph
0
1
2
3
time (ps)


flux (arbitrary units)
CO2
(x35)
CO
0
50
100
150
200
flight time (μs)

Per verificare se il desorbimento di CO e CO2 è regolato da elettroni o da fononi, mando due impulsi di fotoni al variare dell'intervallo (delay) tra i due. Se ho sovrapposizione tra gli effetti dei due impulsi, mi aspetto un aumento del desorbimento. Questo aumento c'è per entrambe le specie, ma il picco la dipendenza dal delay è molto diversa….



Electron-phonon coupling avviene in 1 ps
I fononi poi rilassano in 50 ps (e la temperatura si media su regioni più ampie del cristallo, scendendo localmente)

Qu perciò è evidente che il desorbimento di CO2 è legato a fenomeni fononici (temperatura che aumenta); il desorbimento di CO a fenomeni elettronici (*hot electrons*)

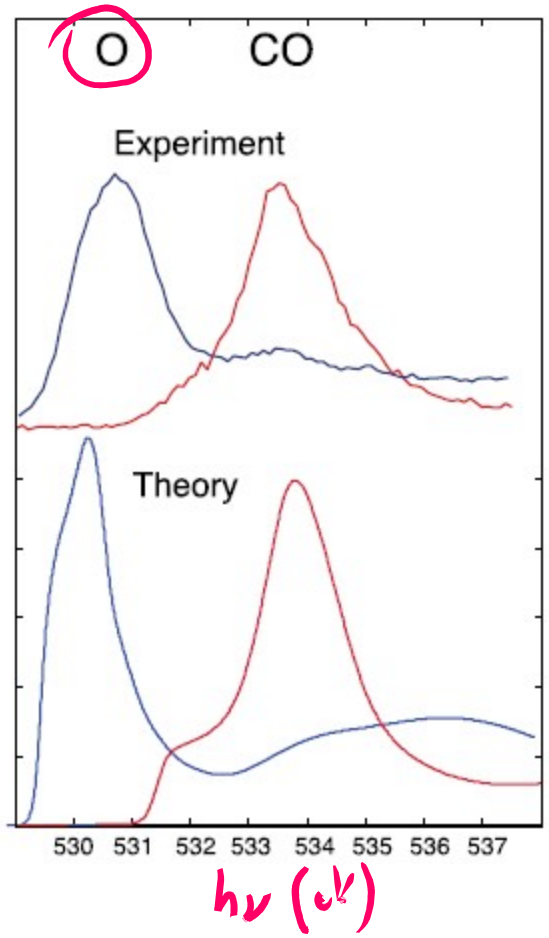
Spettroscopia Pump&Probe

1 Pump | porta il sistema in uno stato eccitato

2 Probe
- fotoemissione
- assorbimento a soglie

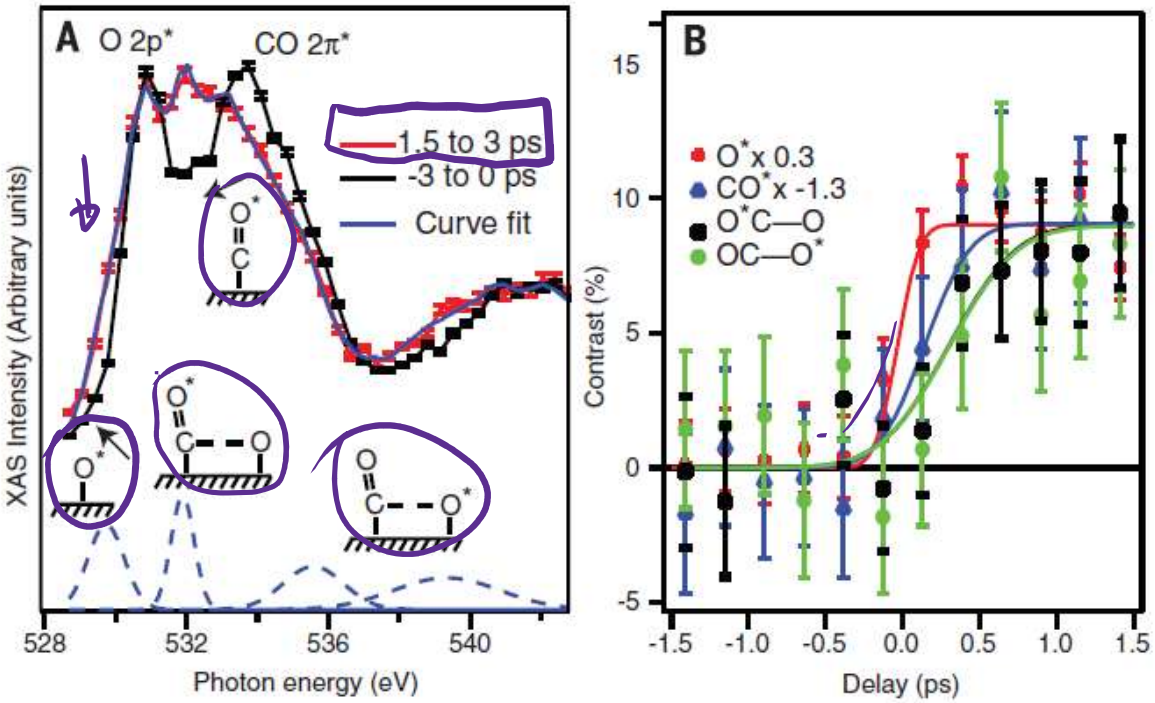
Δt

NEXAFS O_{1s}

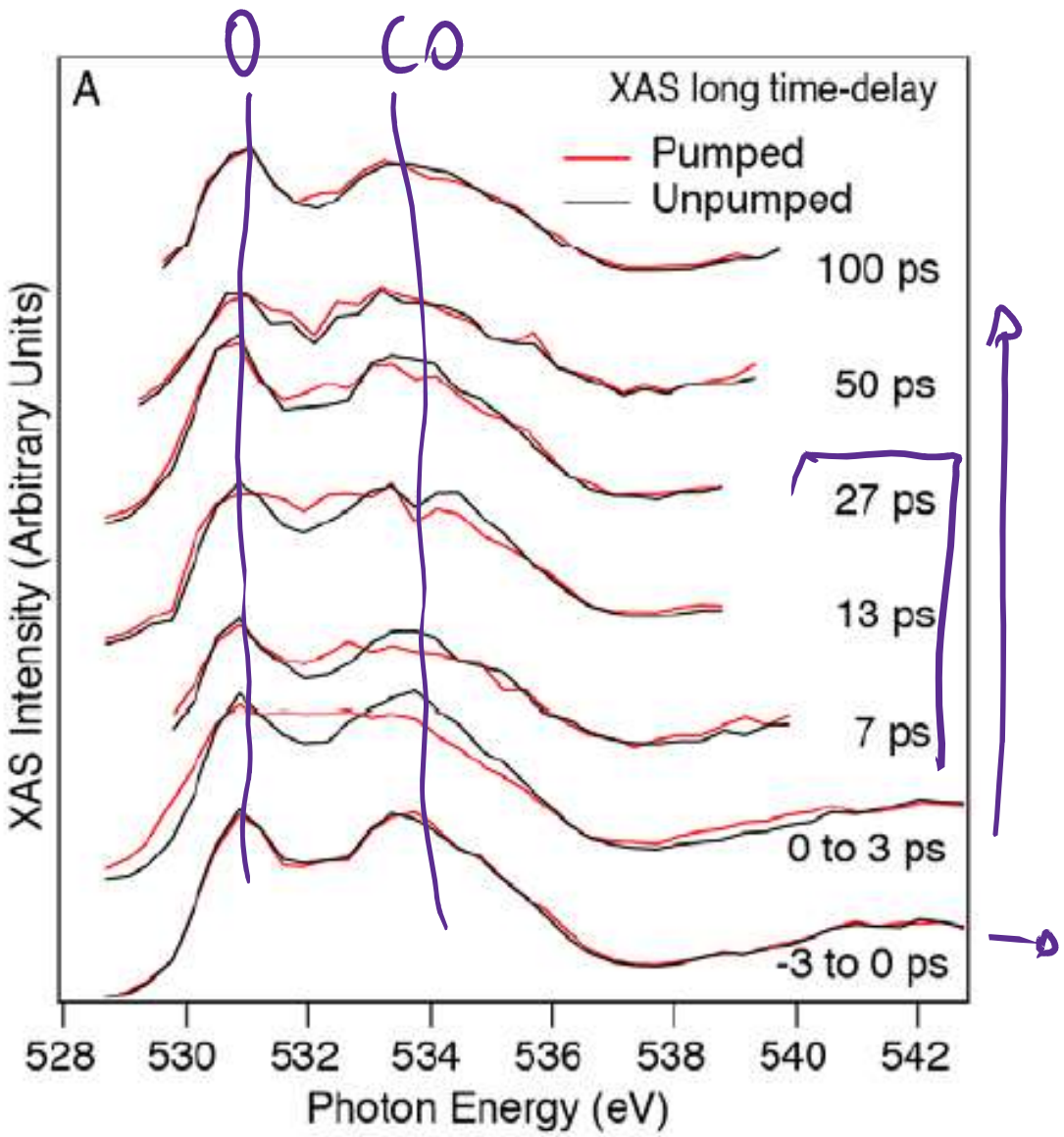


$h\nu_1 \approx 400$ nm

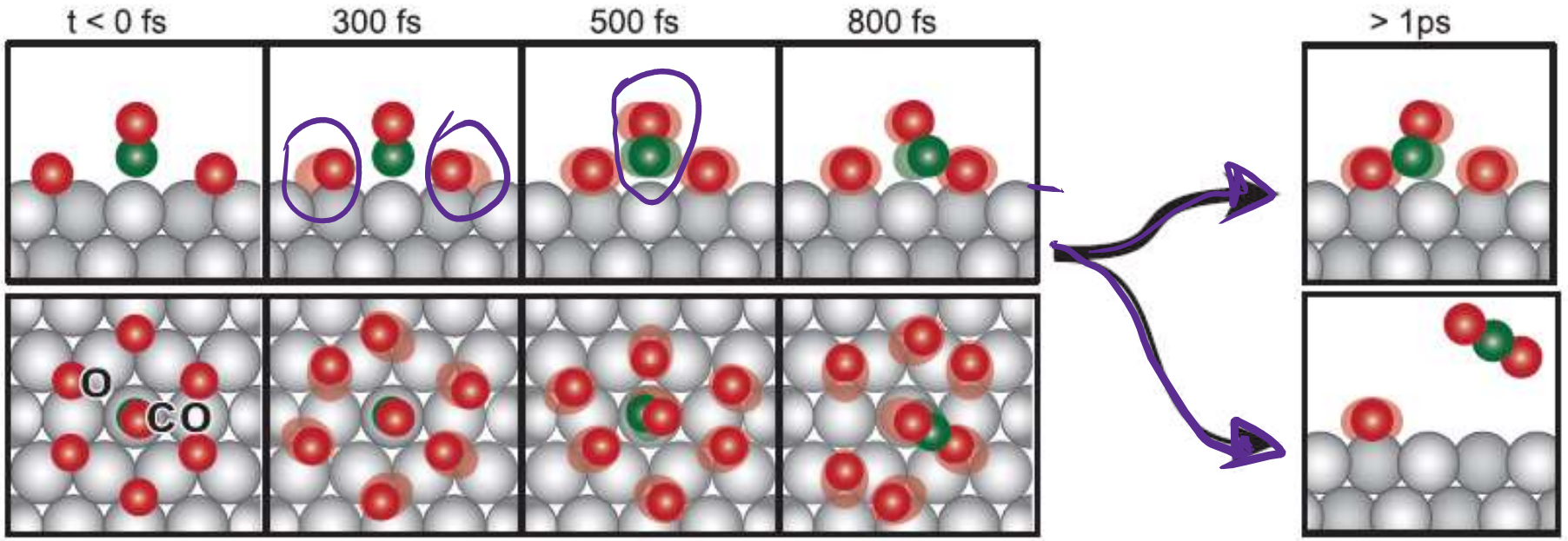
$h\nu_2$



Science, 2015, vol.347

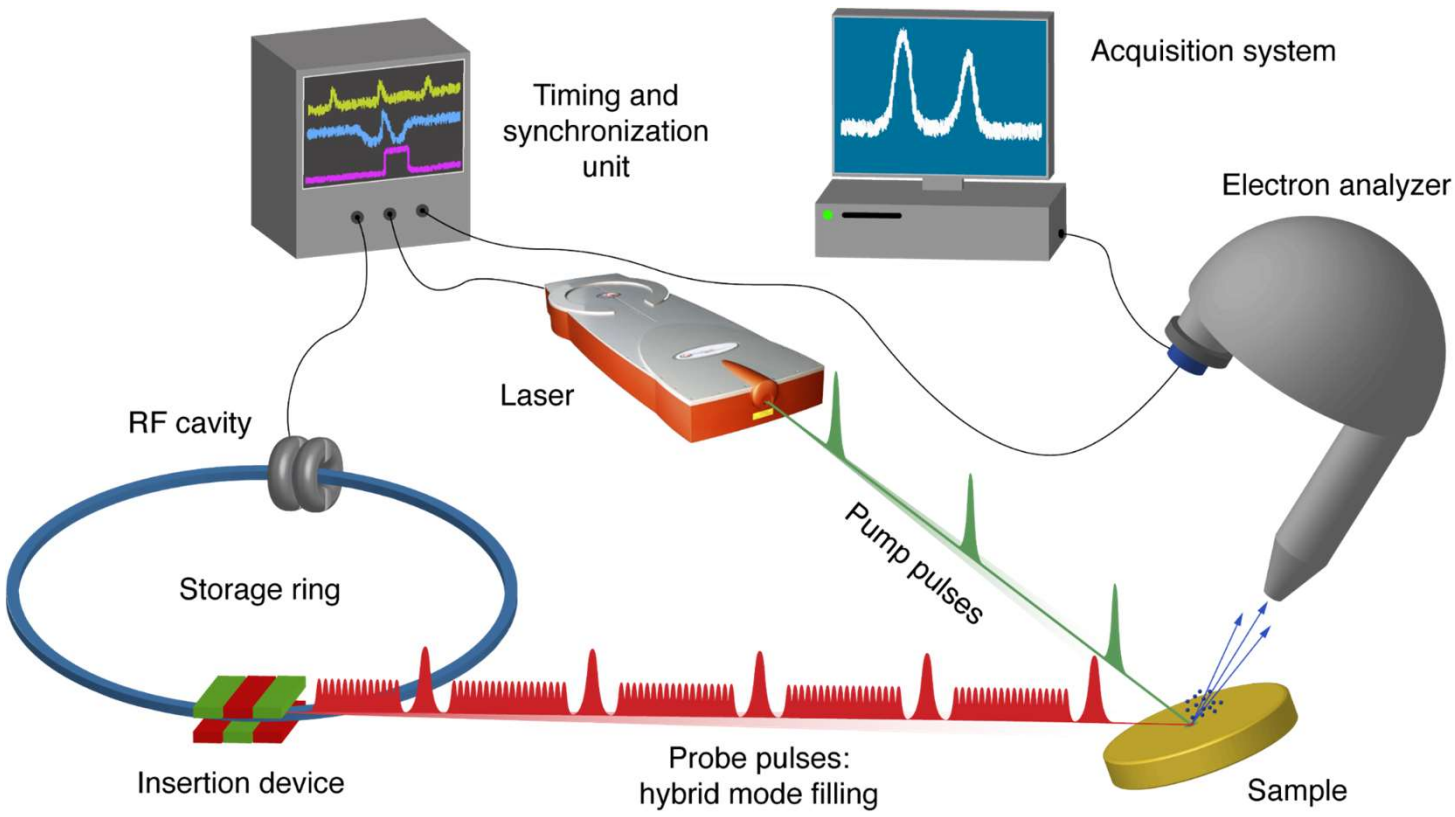


Science, 2015, vol.347

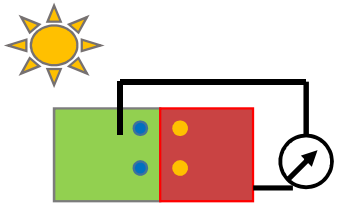


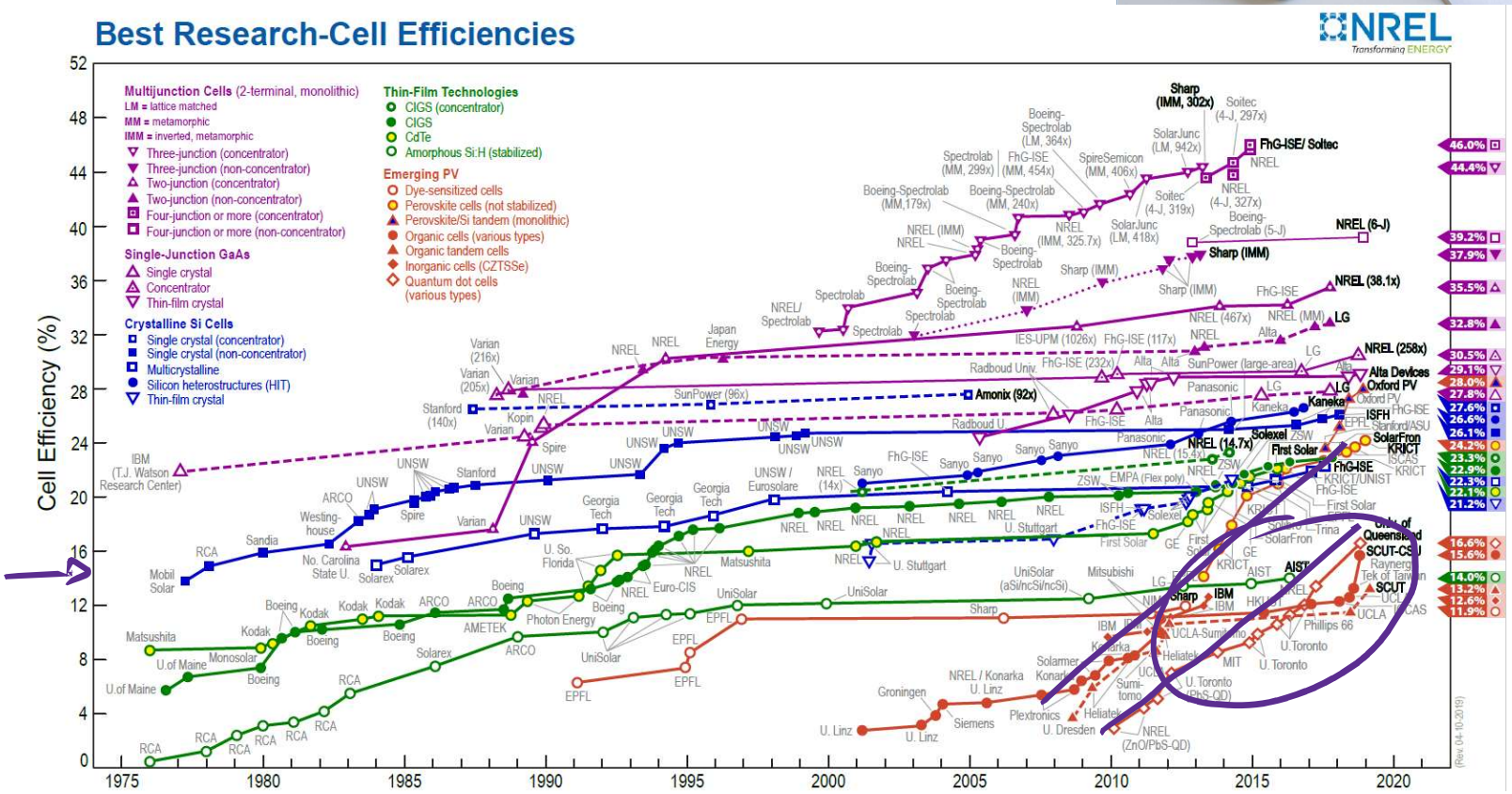
Science, 2015, vol.347

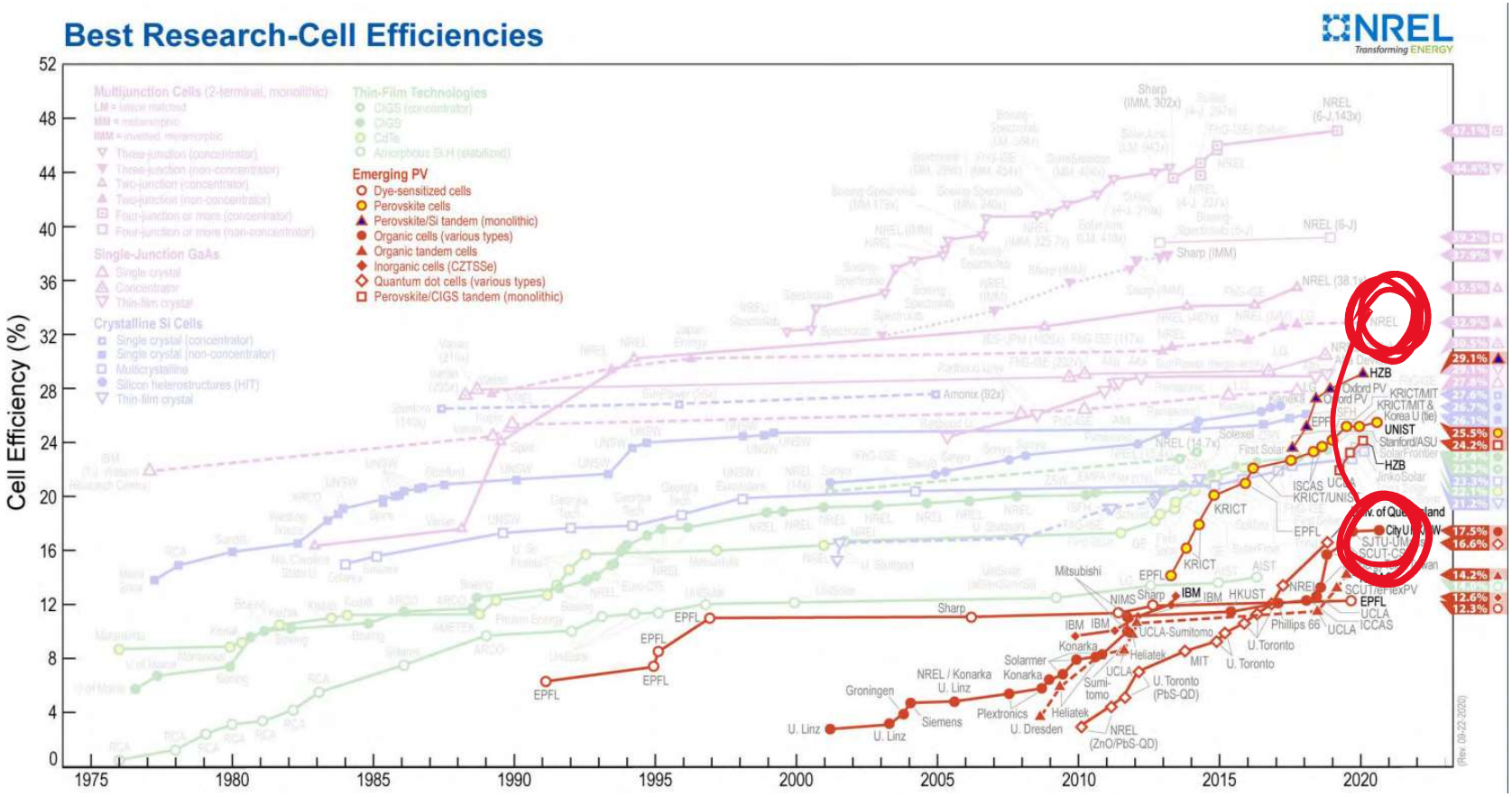
Experimental Set-Up for Optical Pump-X-ray Probe



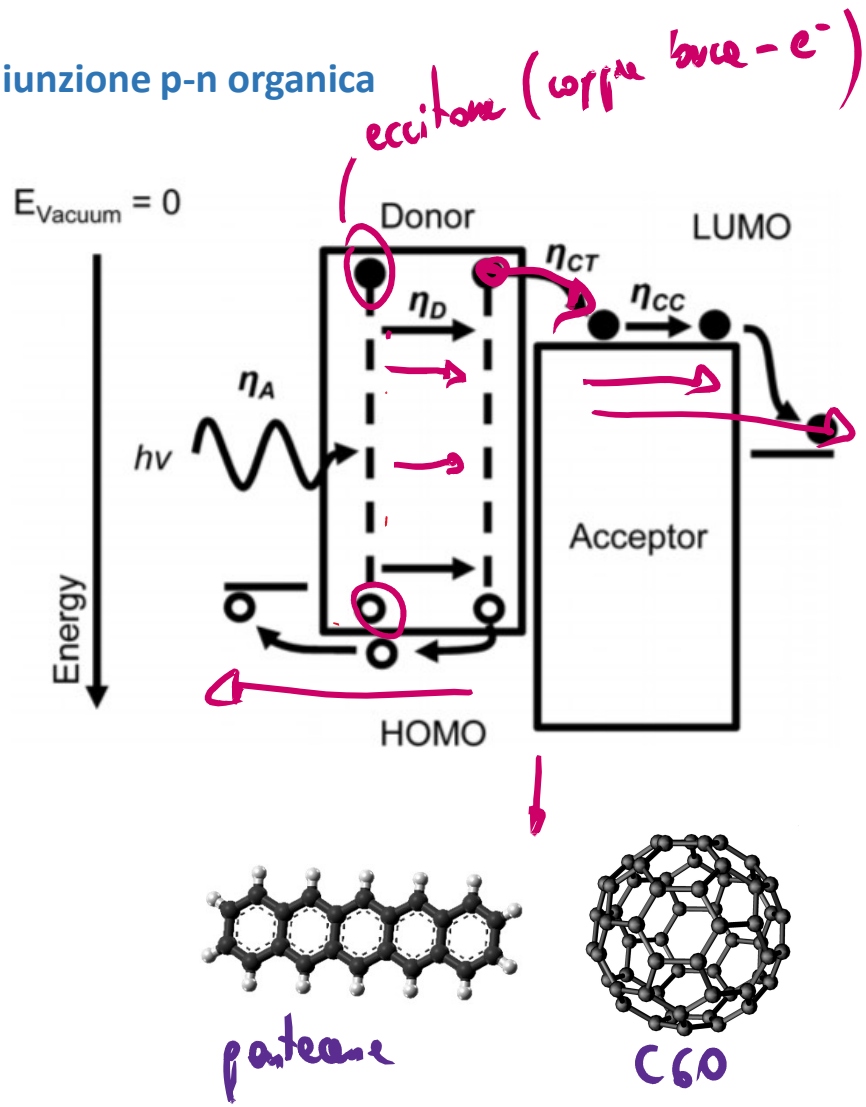
Solar Cells



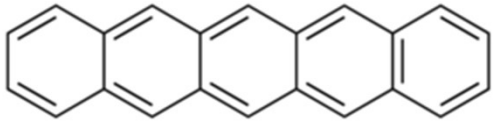

Best Research-Cell Efficiencies
NREL
Transforming ENERGY
Cell Efficiency (%)
Multijunction Cells (2-terminal, monolithic)
LM = lattice matched
MM = metamorphic
IMM = inverted, metamorphic
Three-junction (concentrator)
Three-junction (non-concentrator)
Two-junction (concentrator)
Two-junction (non-concentrator)
Four-junction or more (concentrator)
Four-junction or more (non-concentrator)
Single-Junction GaAs
Single crystal
Concentrator
Thin-film crystal
Crystalline Si Cells
Single crystal (concentrator)
Single crystal (non-concentrator)
Multicrystalline
Silicon heterostructures (HIT)
Thin-film crystal
Thin-Film Technologies
CIGS (concentrator)
CIGS
CdTe
Amorphous Si:H (stabilized)
Emerging PV
Dye-sensitized cells
Perovskite cells (not stabilized)
Perovskite/Si tandem (monolithic)
Organic cells (various types)
Organic tandem cells
Inorganic cells (CZTSSe)
Quantum dot cells (various types)
46.0%
44.4%
39.2%
37.9%
35.5%
32.8%
30.5%
29.1%
28.0%
27.8%
27.6%
26.6%
26.1%
24.2%
23.3%
22.9%
22.3%
22.1%
21.2%
16.6%
15.6%
14.0%
13.2%
12.6%
11.9%
(Rev 04-10-2019)


Best Research-Cell Efficiencies
NREL
Transforming ENERGY
Cell Efficiency (%)
Multijunction Cells (2-terminal, monolithic)
Thin-Film Technologies
Emerging PV
Dye-sensitized cells
Perovskite cells
Perovskite/Si tandem (monolithic)
Organic cells (various types)
Organic tandem cells
Inorganic cells (CZTSSe)
Quantum dot cells (various types)
Perovskite/CIGS tandem (monolithic)
Single-Junction GaAs
Crystalline Si Cells
HZB
UNIST
KRICT
EPFL
Mitsubishi
Sharp
IBM
NREL
U. Toronto
MIT
Phillips 66
UCLA
Konarka
Heliatek
Plextronics
U. Dresden
Siemens
Groningen
U. Linz
Solarmer
Sumi-tomo
NREL (ZnO/PbS-QD)
U. Toronto (PbS-QD)
Amonix (92x)
Sharp (IMM)
NREL (6-J,143x)
NREL (6-J)
29.1%
25.5%
24.2%
17.5%
16.6%
14.2%
12.6%
12.3%
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

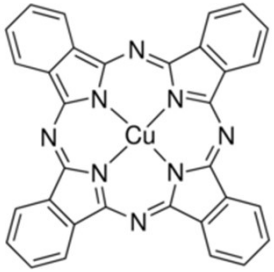
Giunzione p-n organica



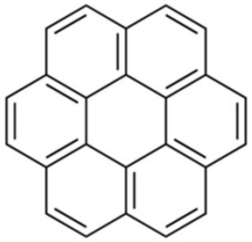
p-type



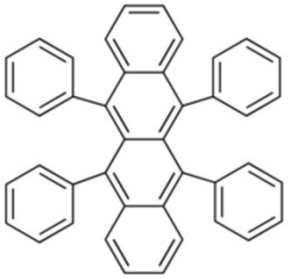
pentacene



CuPc

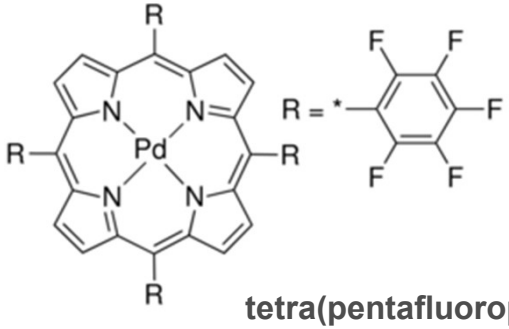


coronene

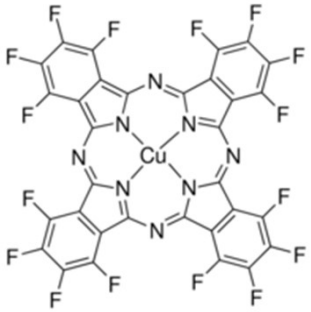


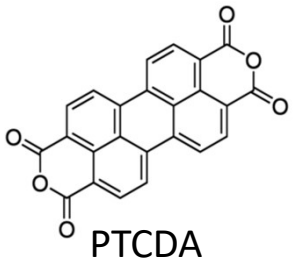
rubrene

n-type



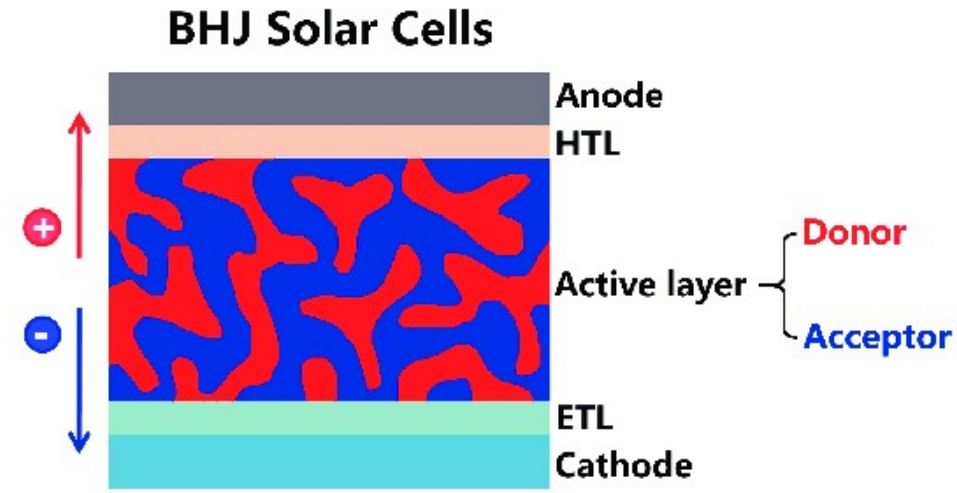
tetra(pentafluorophenyl)porphine

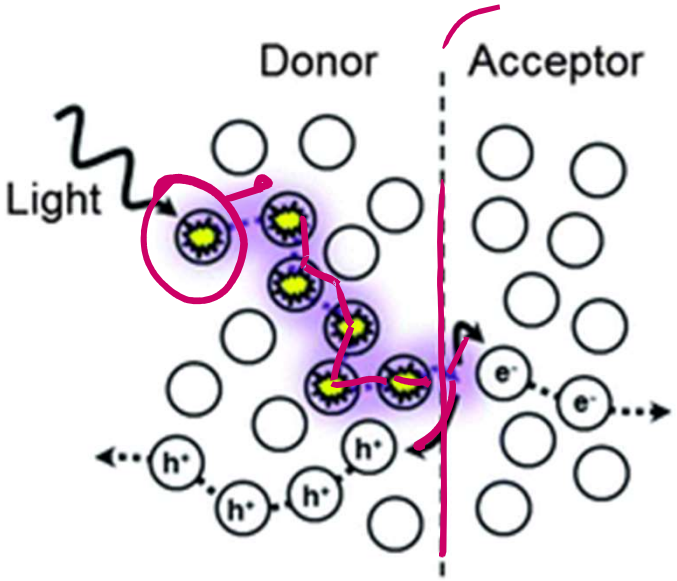


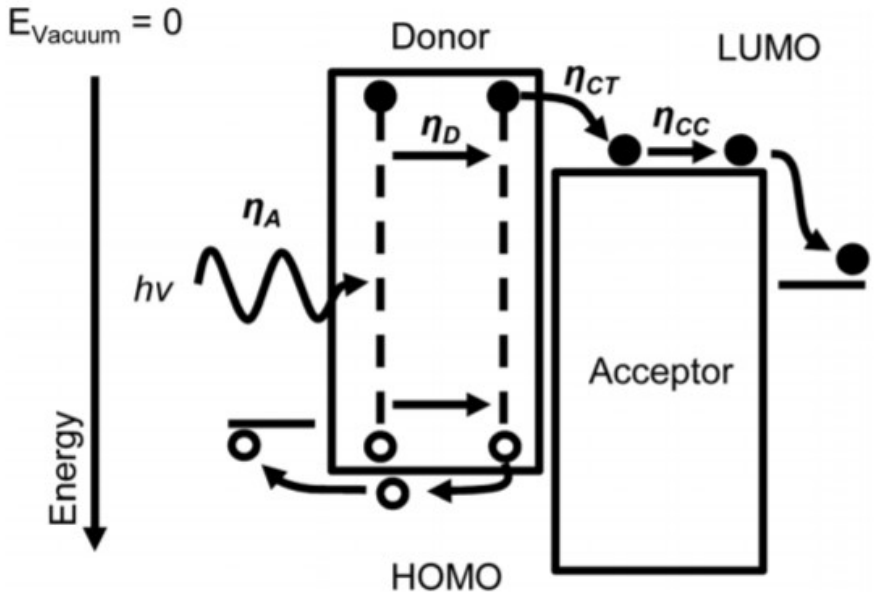


PTCDA

Fullerene

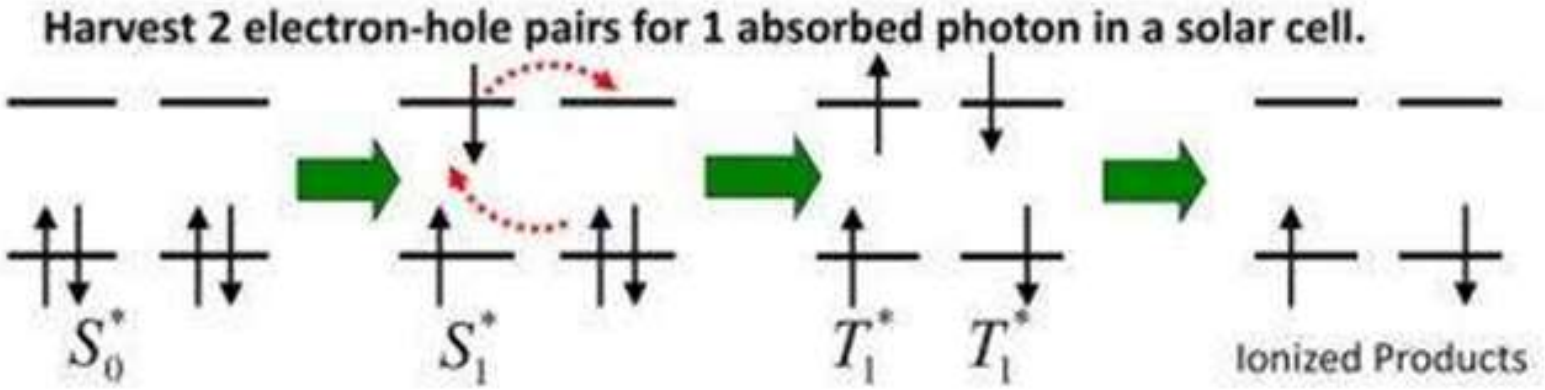


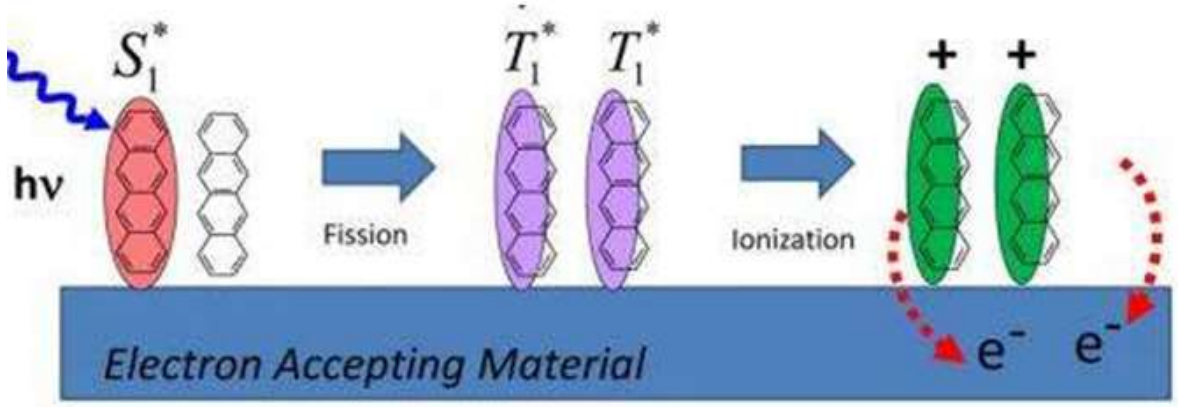




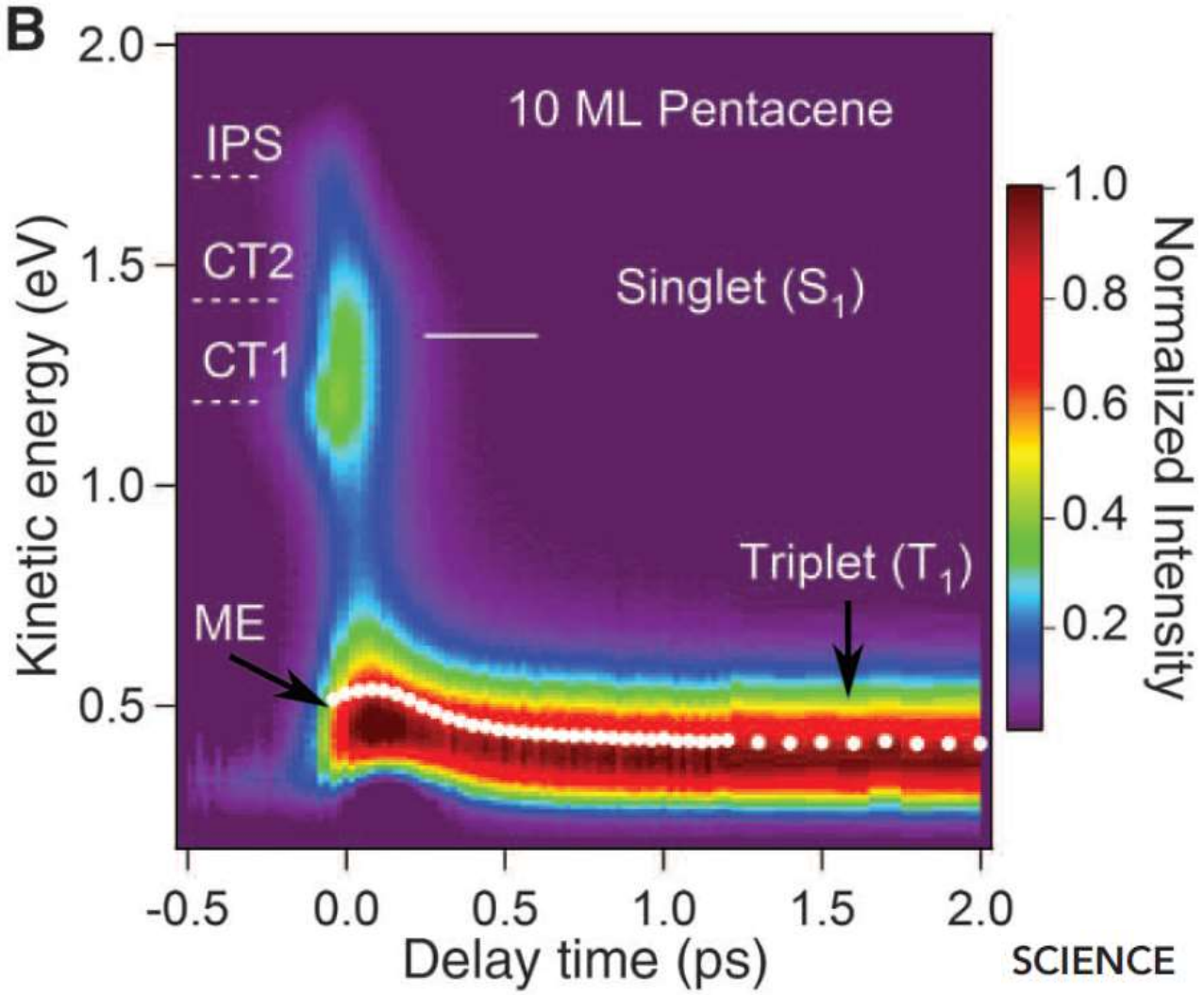
Energy Environ. Sci., 2014,**7**, 499-512

Singlet Fission

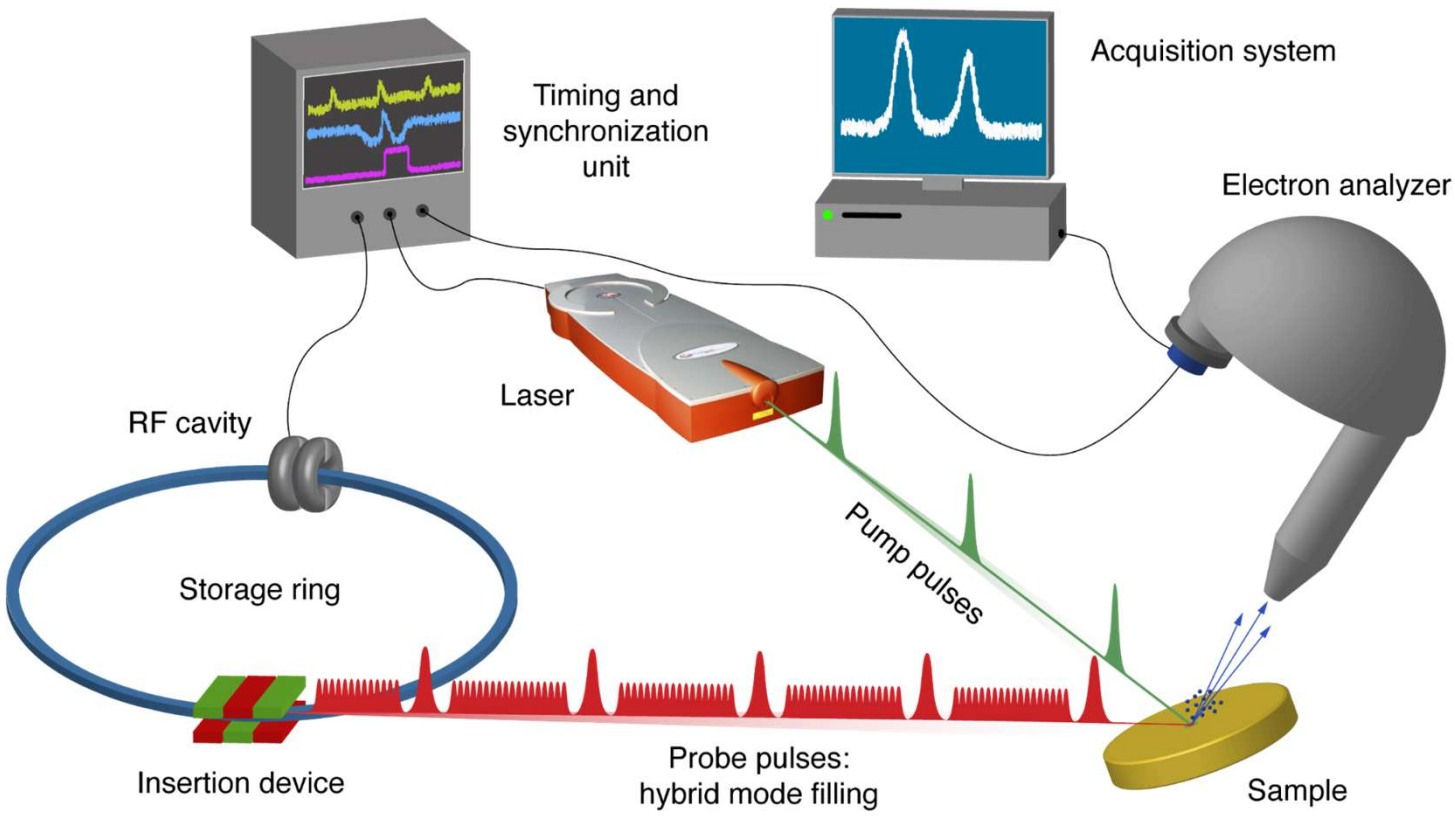




J. Phys. Chem. Lett. 2014, 5, 13, 2312–2319

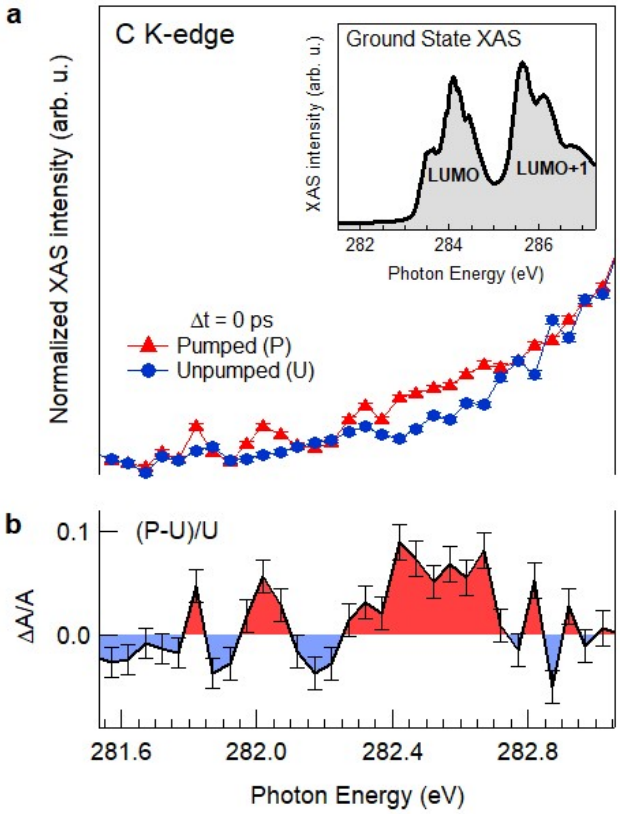

B
10 ML Pentacene
IPS
CT2
CT1
Singlet (S_1)
Triplet (T_1)
ME
Kinetic energy (eV)
2.0
1.5
1.0
0.5
-0.5
0.0
0.5
1.0
1.5
2.0
Delay time (ps)
1.0
0.8
0.6
0.4
0.2
Normalized Intensity

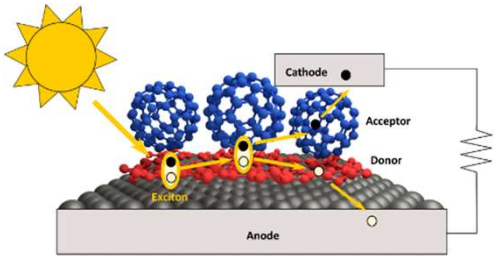
Experimental Set-Up for Optical Pump-X-ray Probe

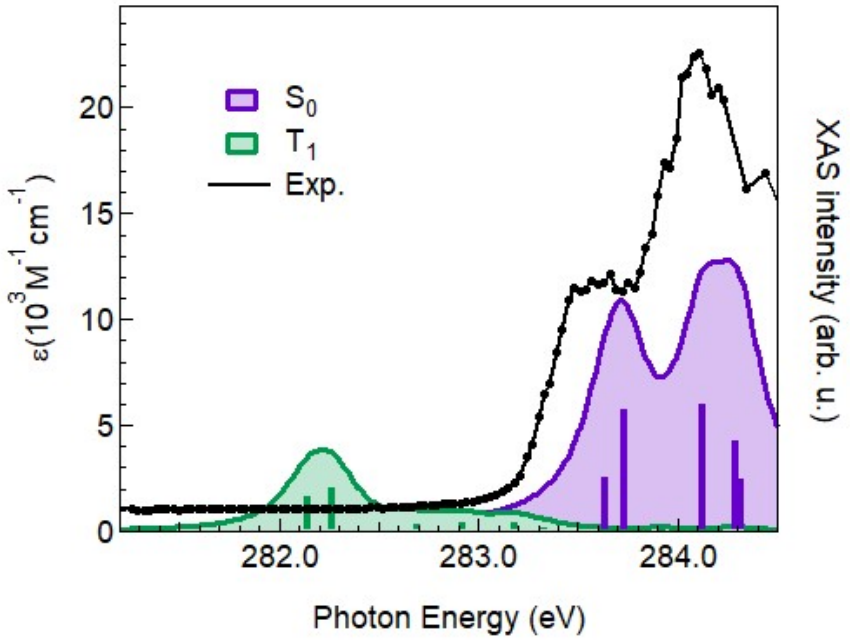


Time resolved XAS

Triplet picosecond dynamics with chemical sensitivity







Commun Phys **2,** 56 (2019)