SWITCHELEC (2013 – 2016):
Switchable molecules for nanoelectronics and spintronics

Partners:
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- Stefan cel Mare University, Suceava, Romania (A. Rotaru)

LCC

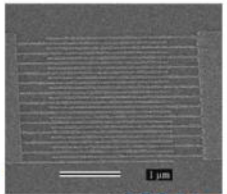
cnrs Toulouse

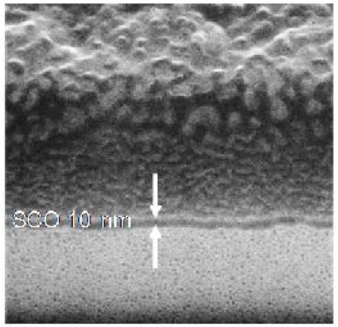
Universitatea Ştefan cel Mare Suceava

USU

NANOMAT

Advanced Multifunctional Materials Laboratory



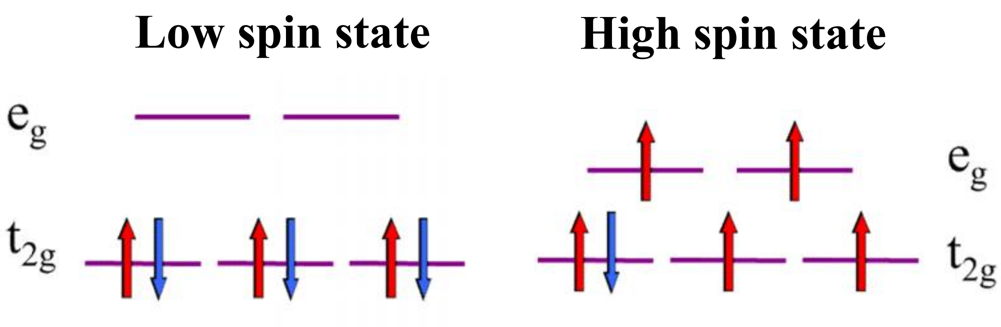


AGENCE NATIONALE DE LA RECHERCHE ANR

uefiscdi INOVARE SI CREATIVITATE

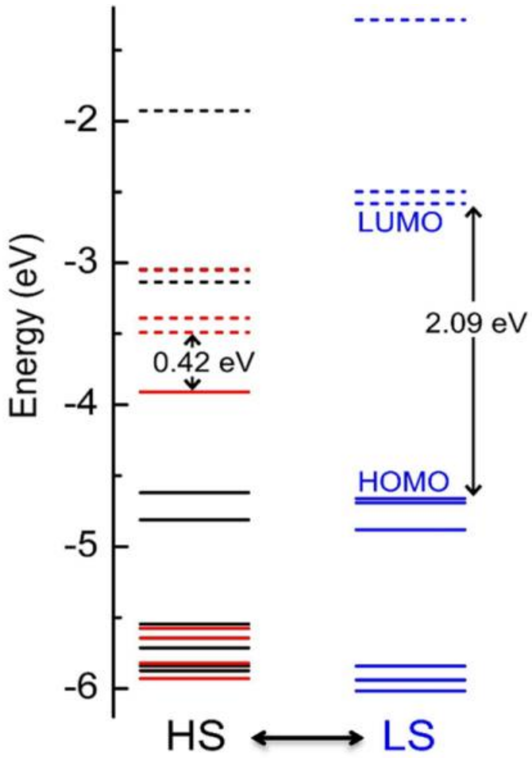
UNITATEA EXECUTIVA PENTRU FINANTAREA INVATAMANTULUI SUPERIOR, A CERCETARII DEZVOLTARII SI INOVARII

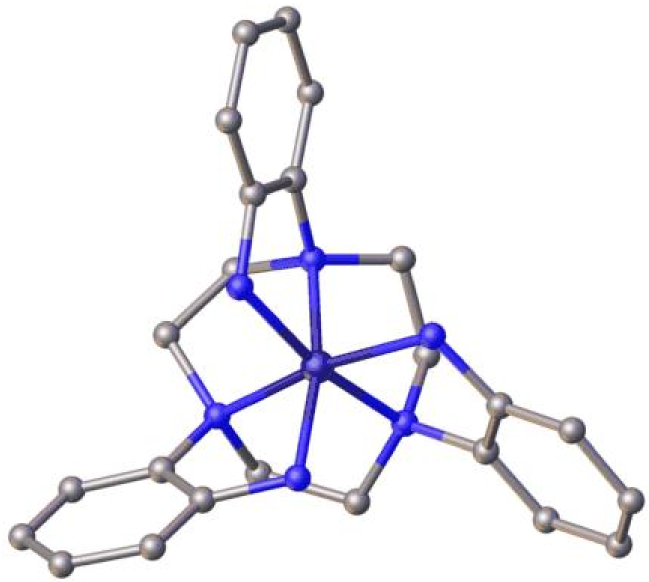
Spin crossover for electronic devices: rationale

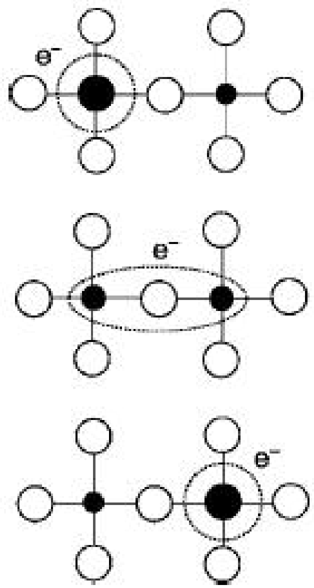


Electrical
Magnetic
Mechanical
Thermal
Optical

properties

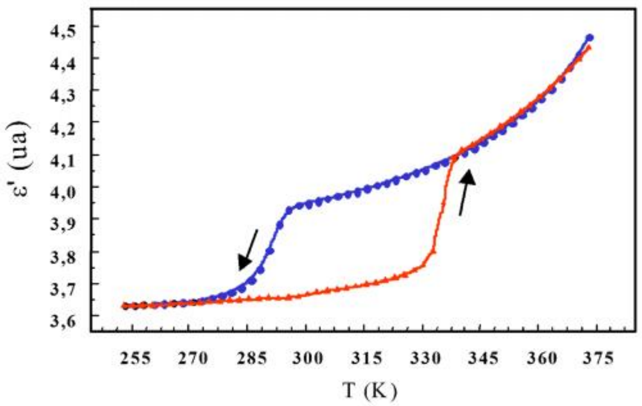






Review

Charge Transport and Electrical Properties of Spin Crossover Materials: Towards Nanoelectronic and Spintronic Devices



J Mater Chem 2003, 13, 2069
Angew Chem Int Ed 2006, 45, 1625
Phys Stat Solidi a 2006, 203, 2974
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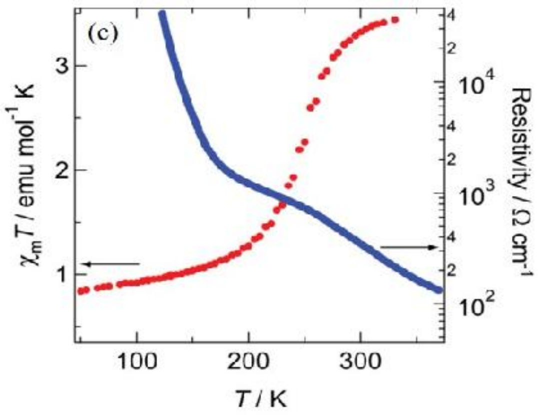

Mol Cryst Liq Cryst 2002, 379, 365
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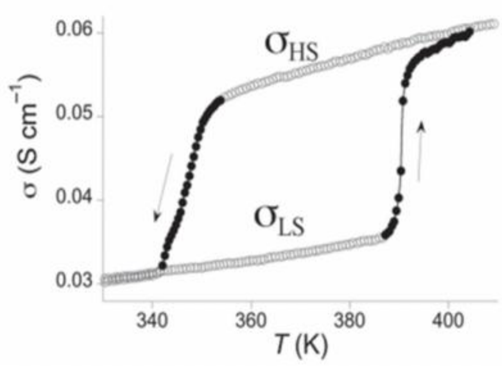
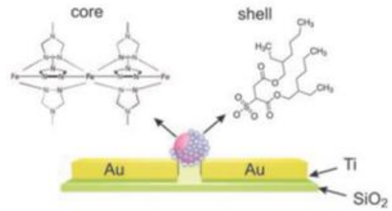


Adv Mater 2014, 26, 6785



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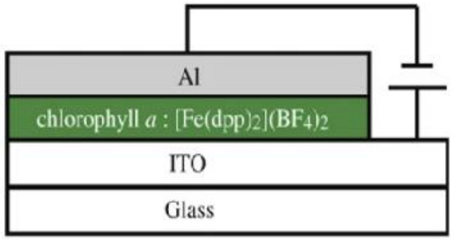

Thin Solid Films 2008, 517, 1465
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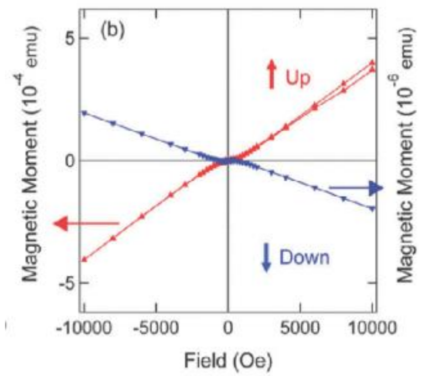

Appl Phys Lett 2009, 95, 043303.
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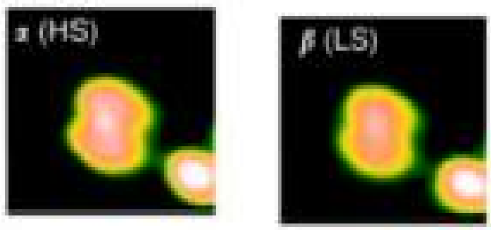
Chem Commun 2014, 50, 2255



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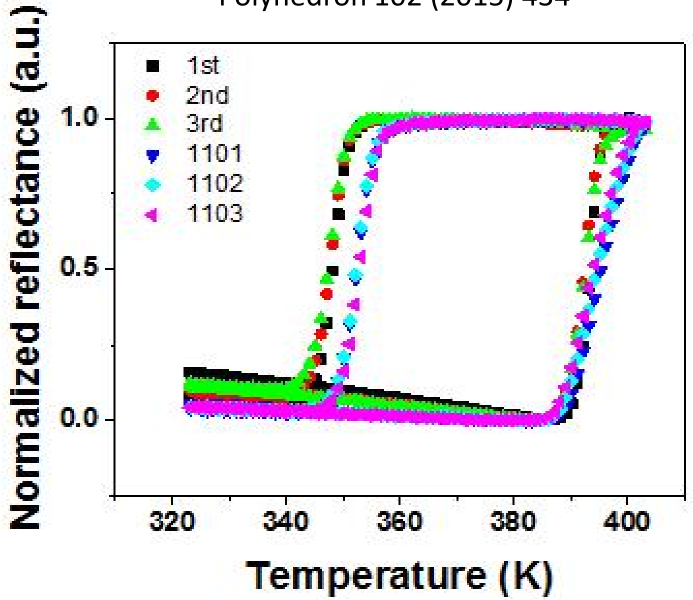
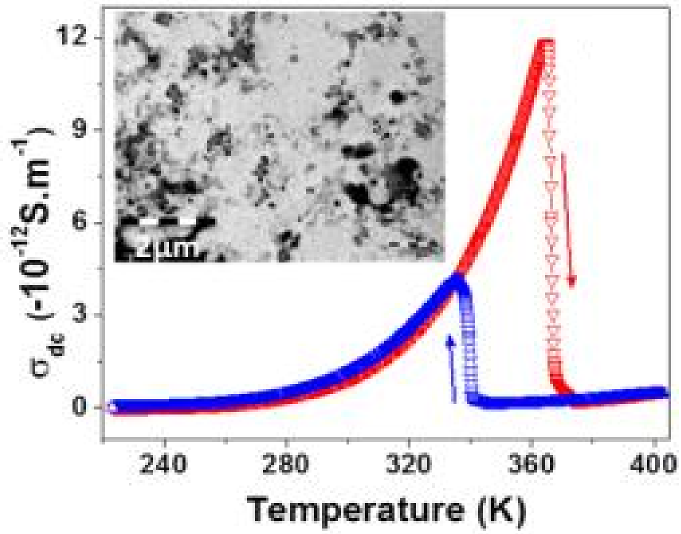
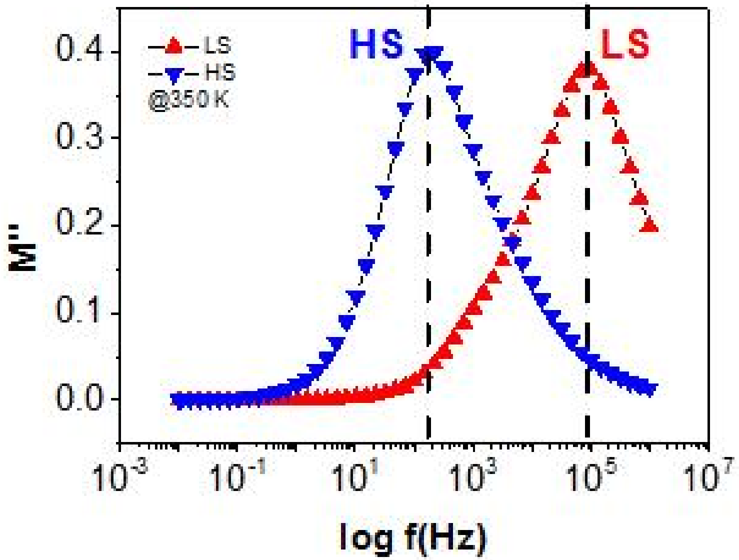
The $[Fe(Htrz)_2(trz)](BF_4)$ spin crossover complex

Polyhedron 102 (2015) 434



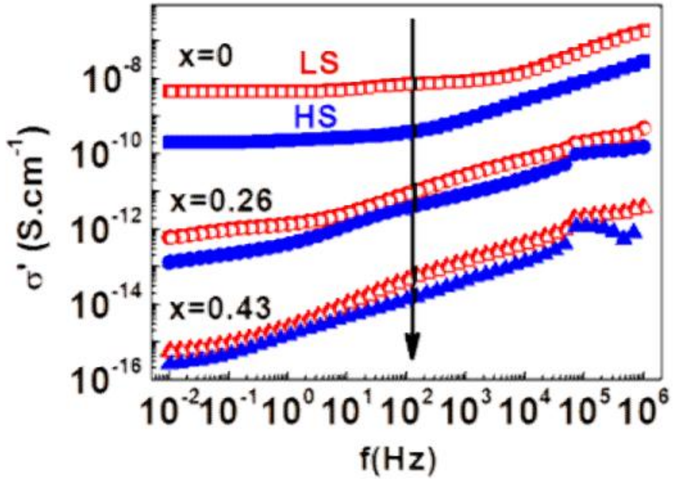
Chem. Commun. 48 (2012) 4163





Phys. Status Solidi (RRL) 8 (2014) 191

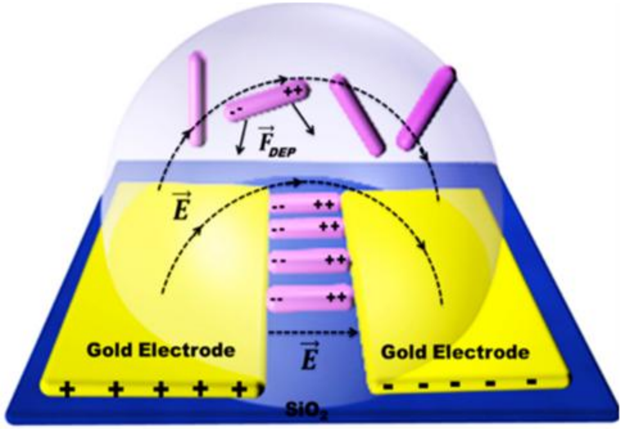
$[Fe_{1-x}Zn_x(Htrz)_2(trz)](BF_4)$

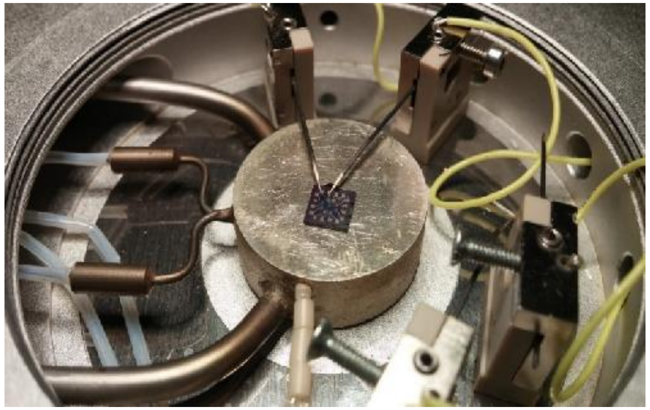


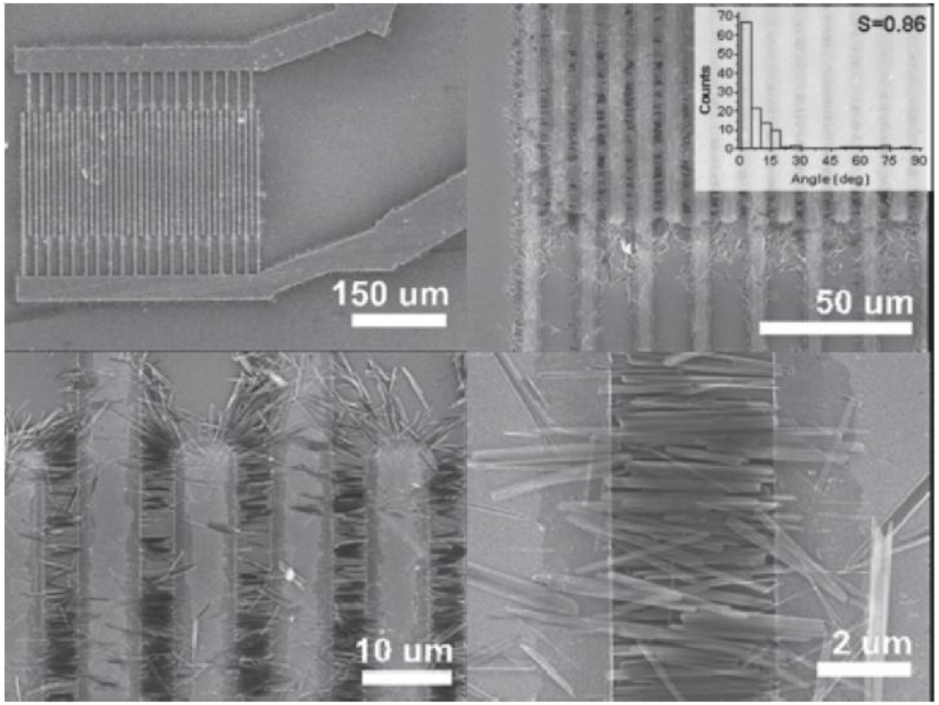
J. Phys. Chem. C 119 (2015) 8522

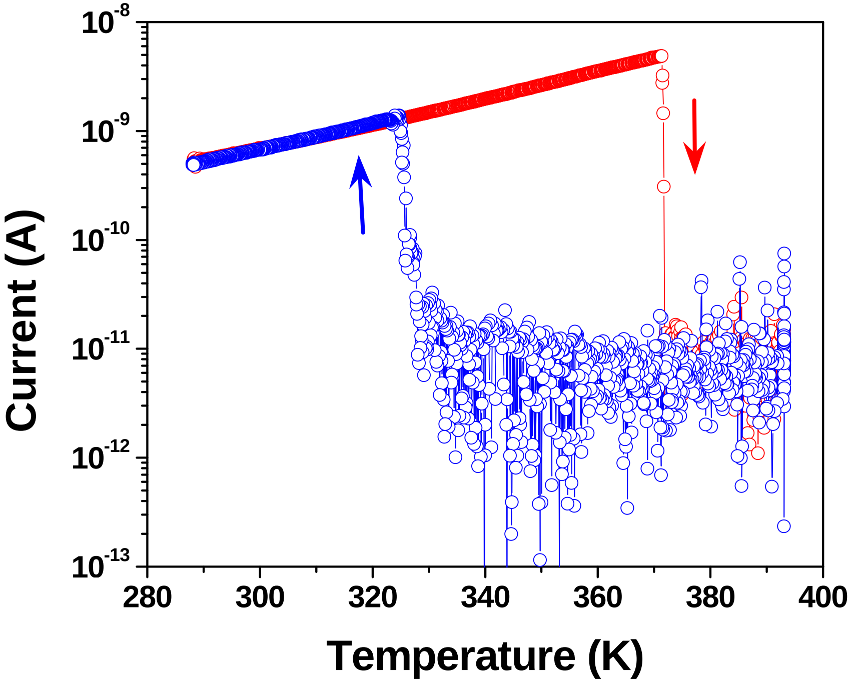
Planar device with $[Fe(Htrz)_2(trz)](BF_4)$

Adv Mater 25 (2013) 1745

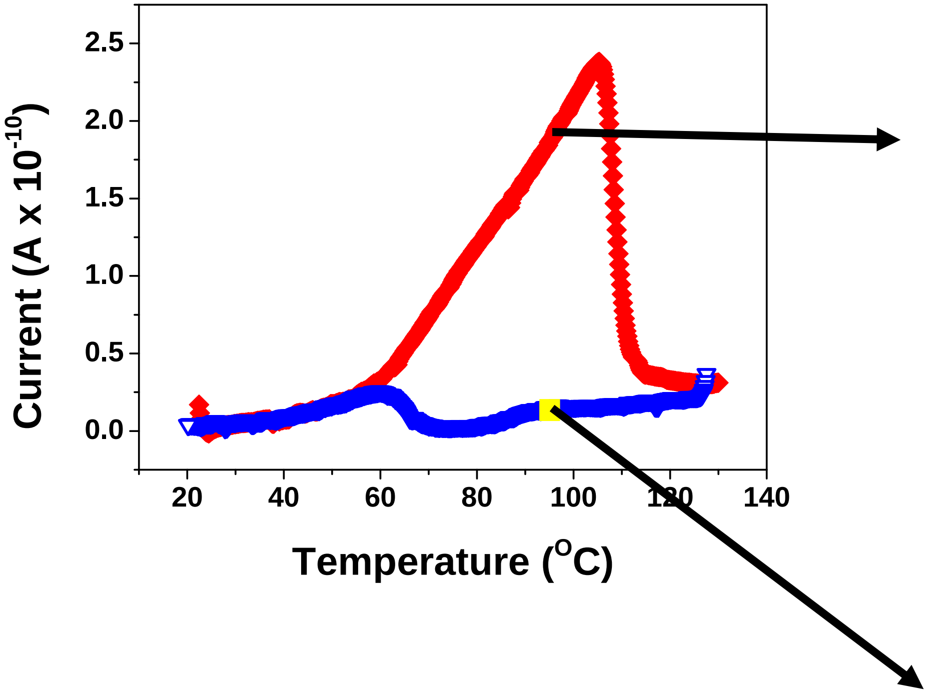


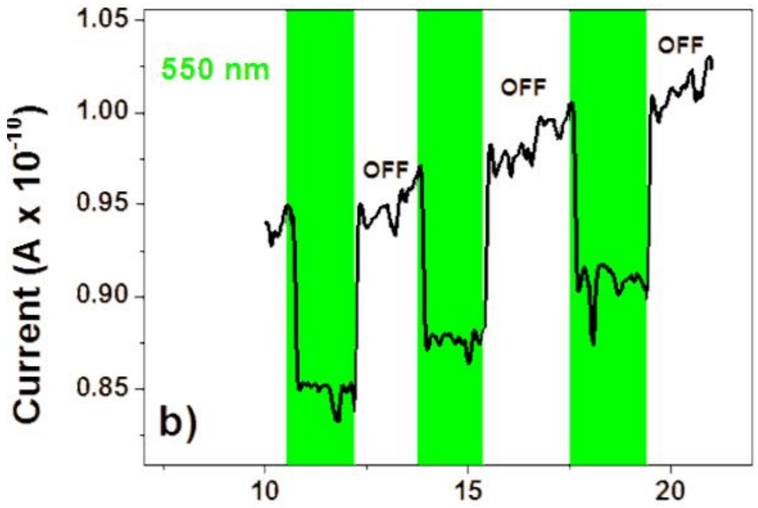


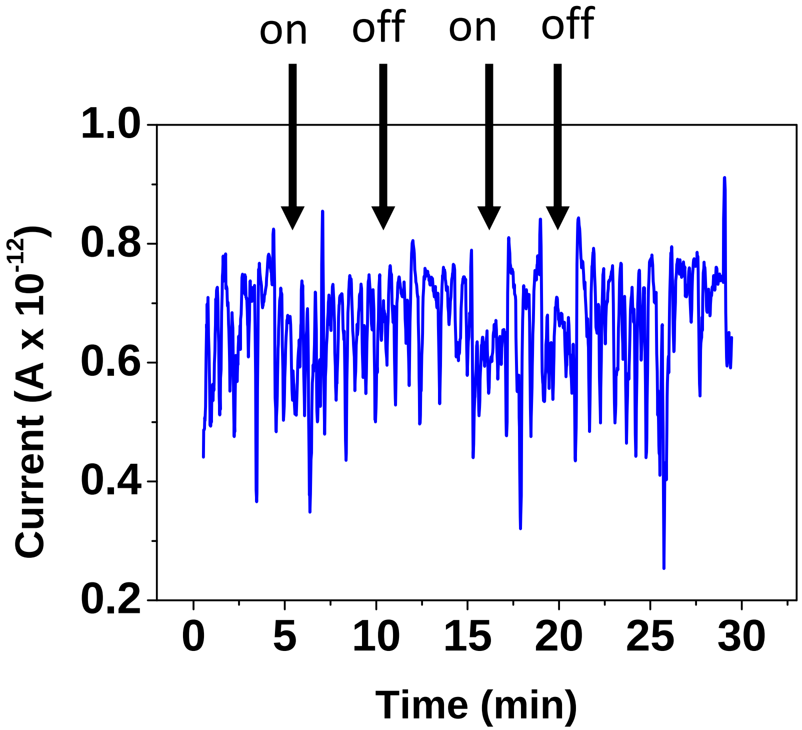




Light irradiation effects on $[Fe(Htrz)_2(trz)](BF_4)$



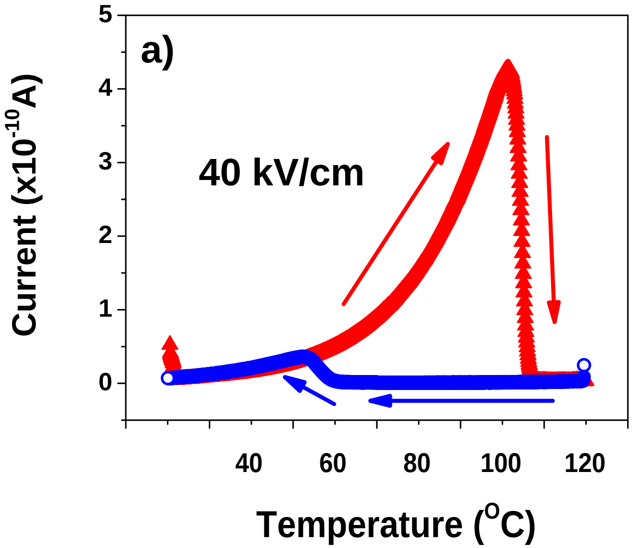


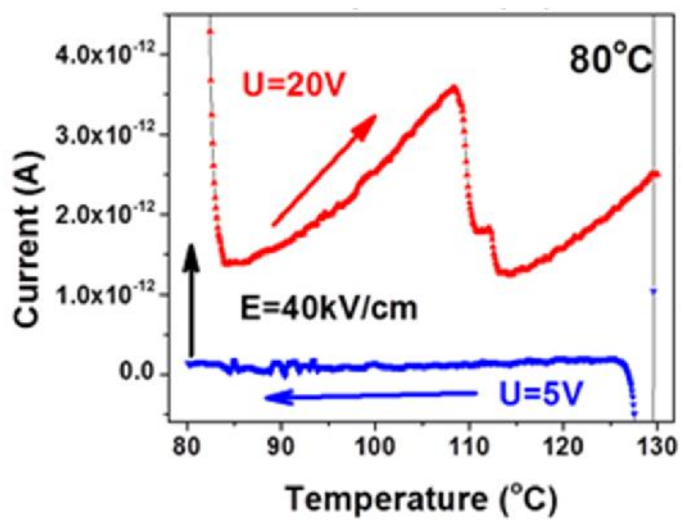


Phys. Chem. Chem. Phys. 17 (2015) 5151.

Electric field effect on $[Fe(Htrz)_2(trz)](BF_4)$

Chem Phys Lett 644 (2016) 138





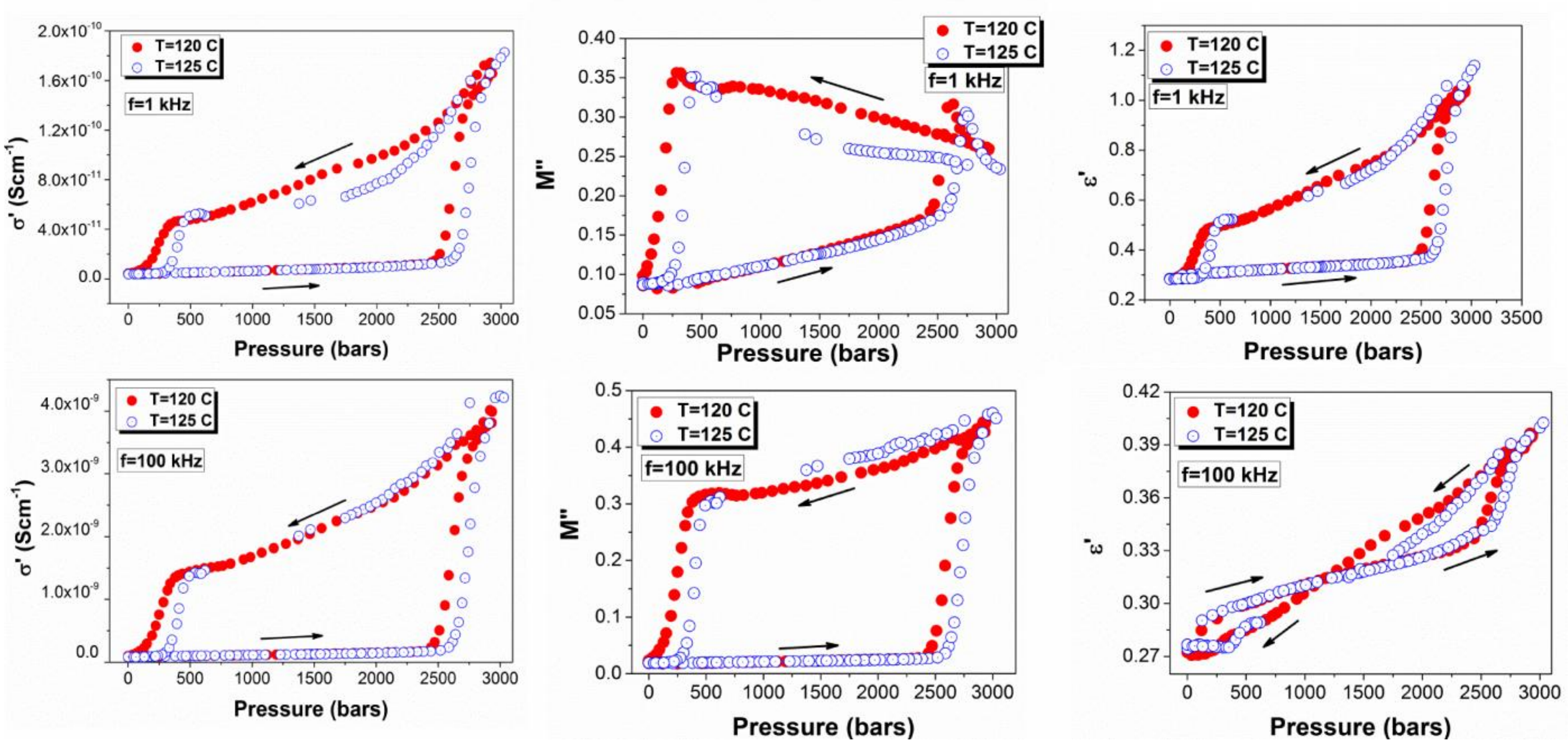
$$H = -J\sum_{\langle i,j\rangle} \pm_i \pm_j + \left[\frac{\Delta}{2} - k_B T \ln\left(\frac{g_{HS}}{g_{LS}}\right)\right]\sum_{i=1}^{N} \pm_i + H_{elec}$$

$$\langle H_{elec}\rangle\left(\{\pm\}\right) = -\frac{p_{HS}^2 - p_{LS}^2}{6k_B T} E^2 \sum_{i=1}^{N} \pm_i$$

$$T_{eq}(E) \approx T_{eq}(E=0) - \frac{p_{HS}^2 - p_{LS}^2}{6k_B^2 \Delta} E^2$$

Pressure effect on $[Fe(Htrz)_2(trz)](BF_4)$

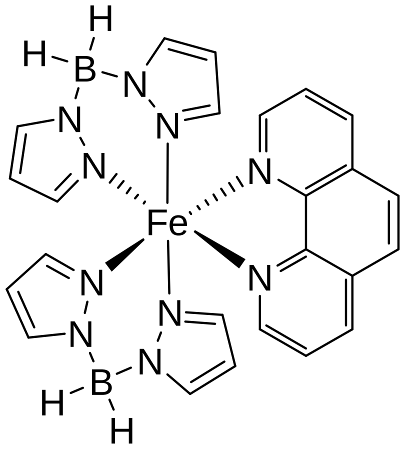
Electrical conductivity | **Electrical modulus** | **Dielectric permitivity**

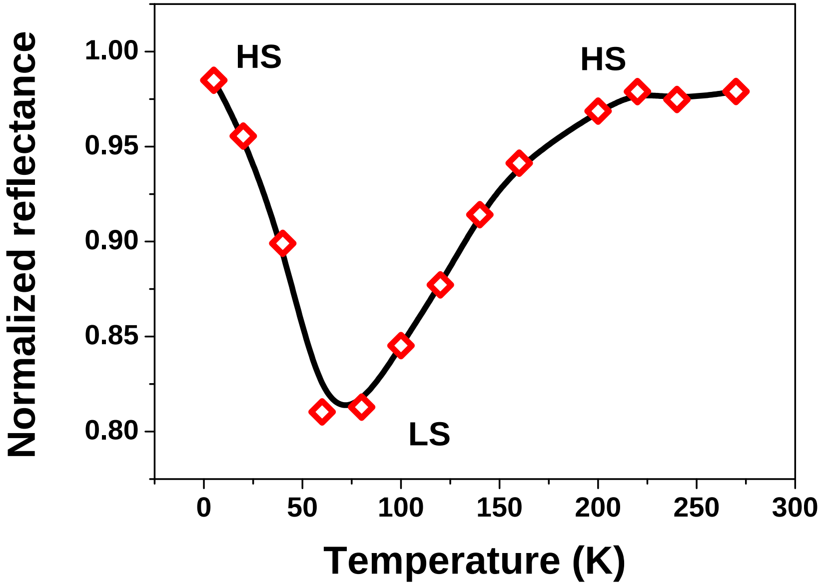


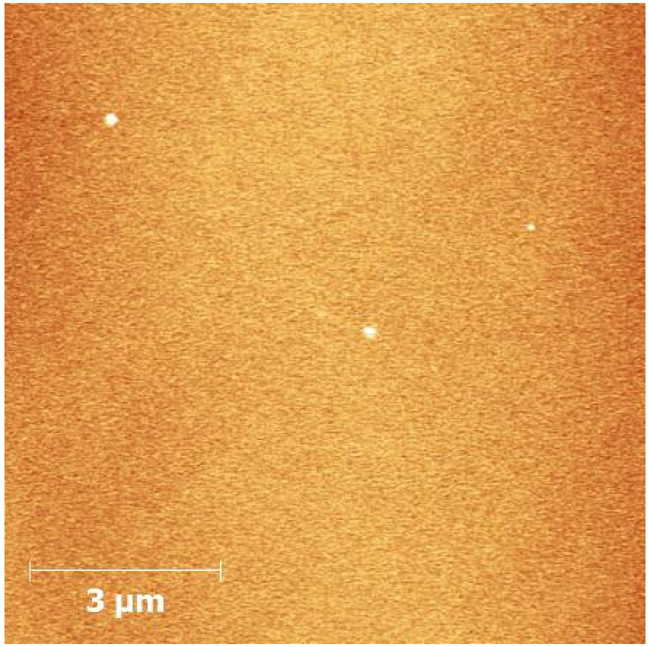
To be published

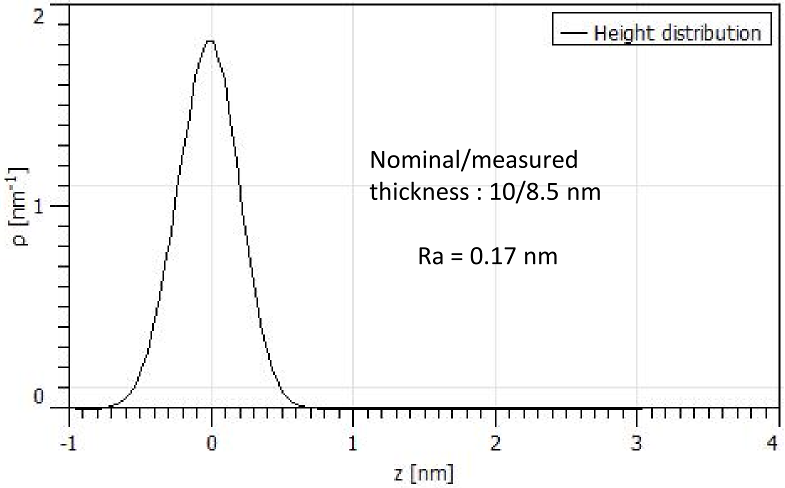
The $[Fe(H_2B(pyrazolyl)_2)_2(phen)]$ spin crossover complex

Inorg. Chem. 1997, 36, 3008

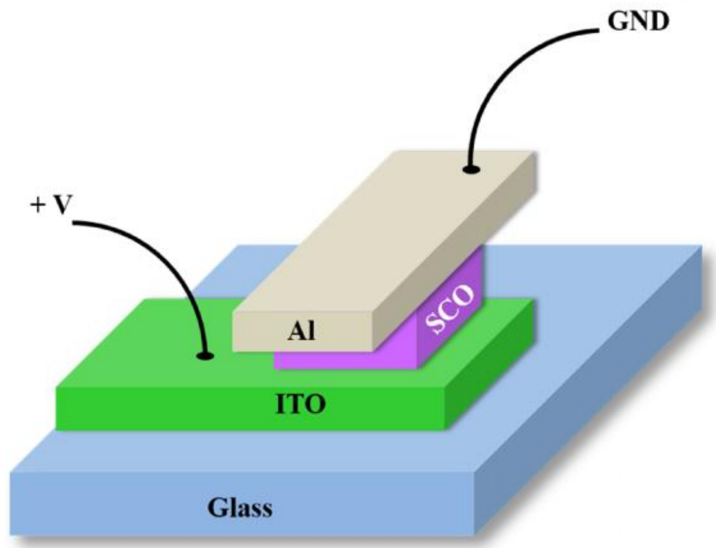


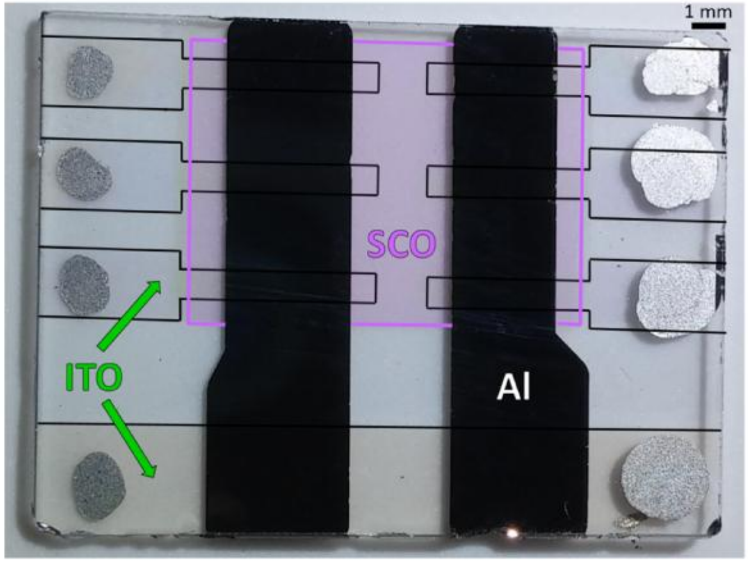


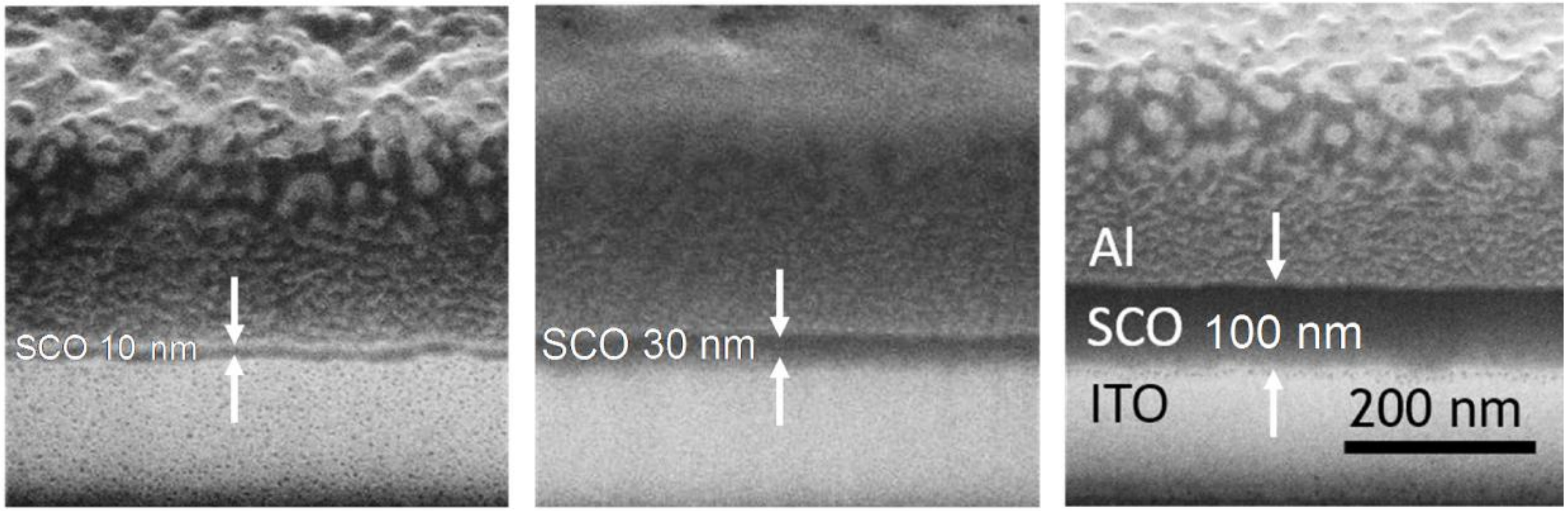




Large area vertical device with [Fe(H_2B(pyrazolyl)$_2$)$_2$(phen)]

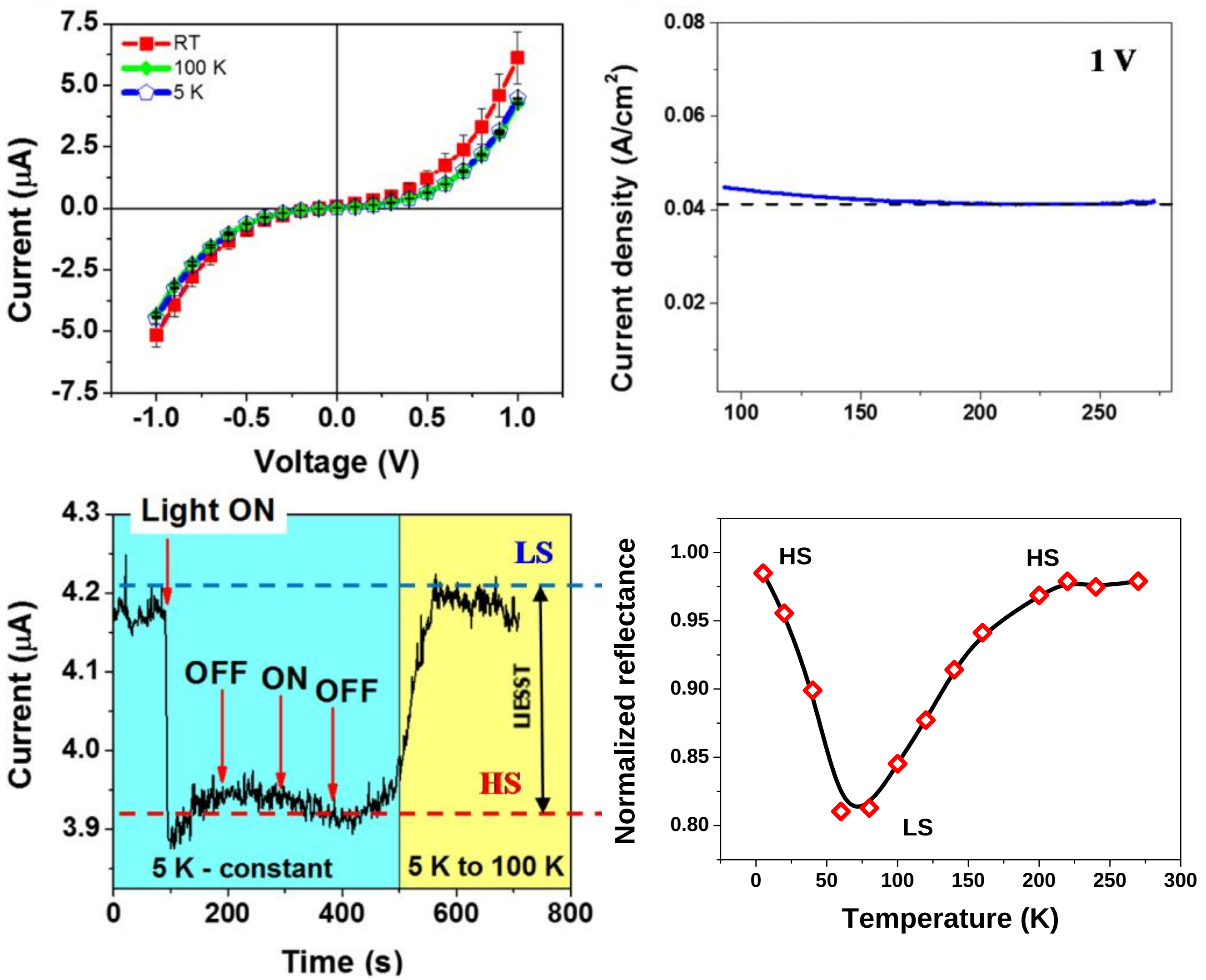






Adv Mater 2016, 28, 7508

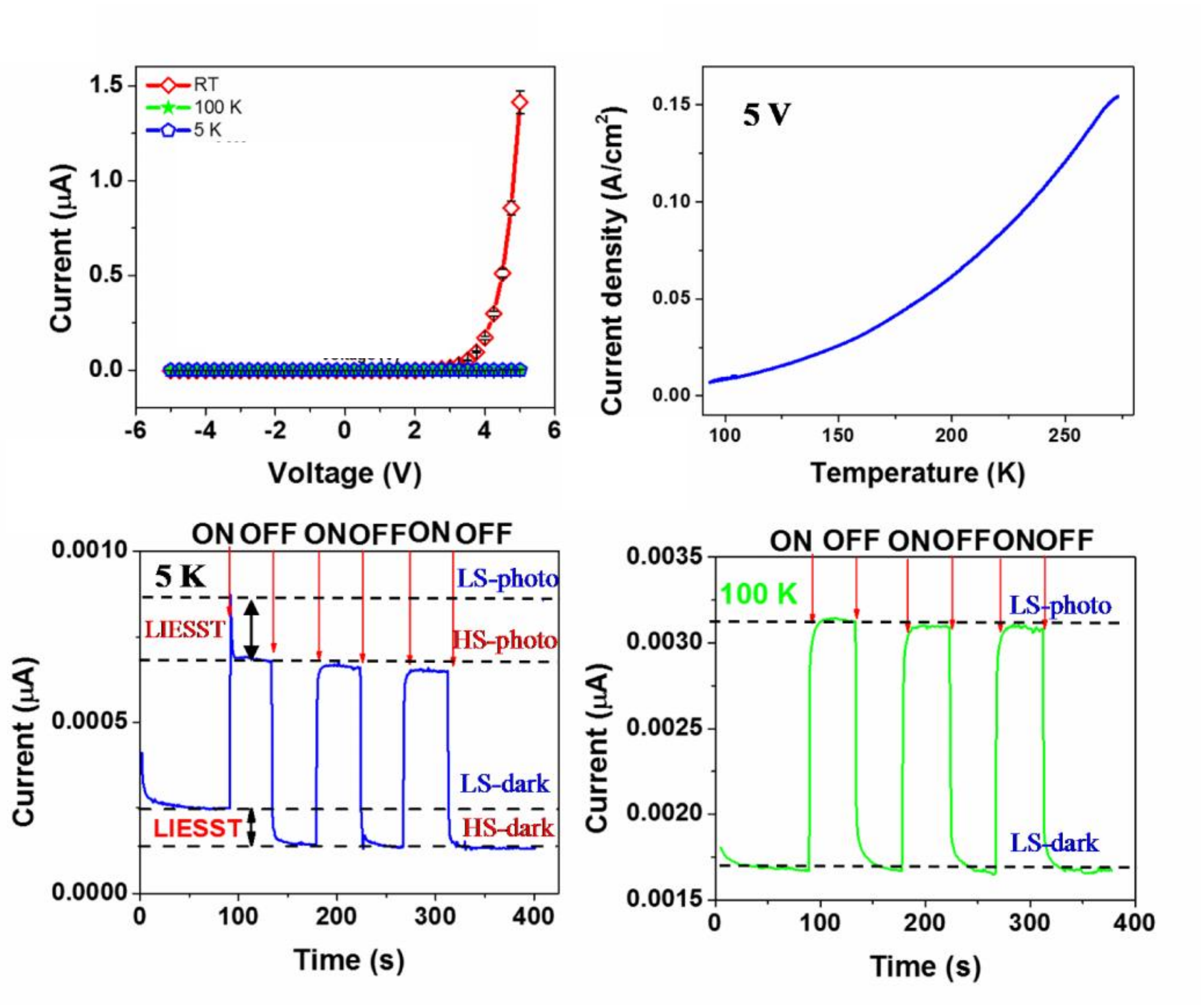
10 nm thick junction of [Fe(H_2B(pyrazolyl)$_2$)$_2$(phen)]



Adv Mater 2016, 28, 7508

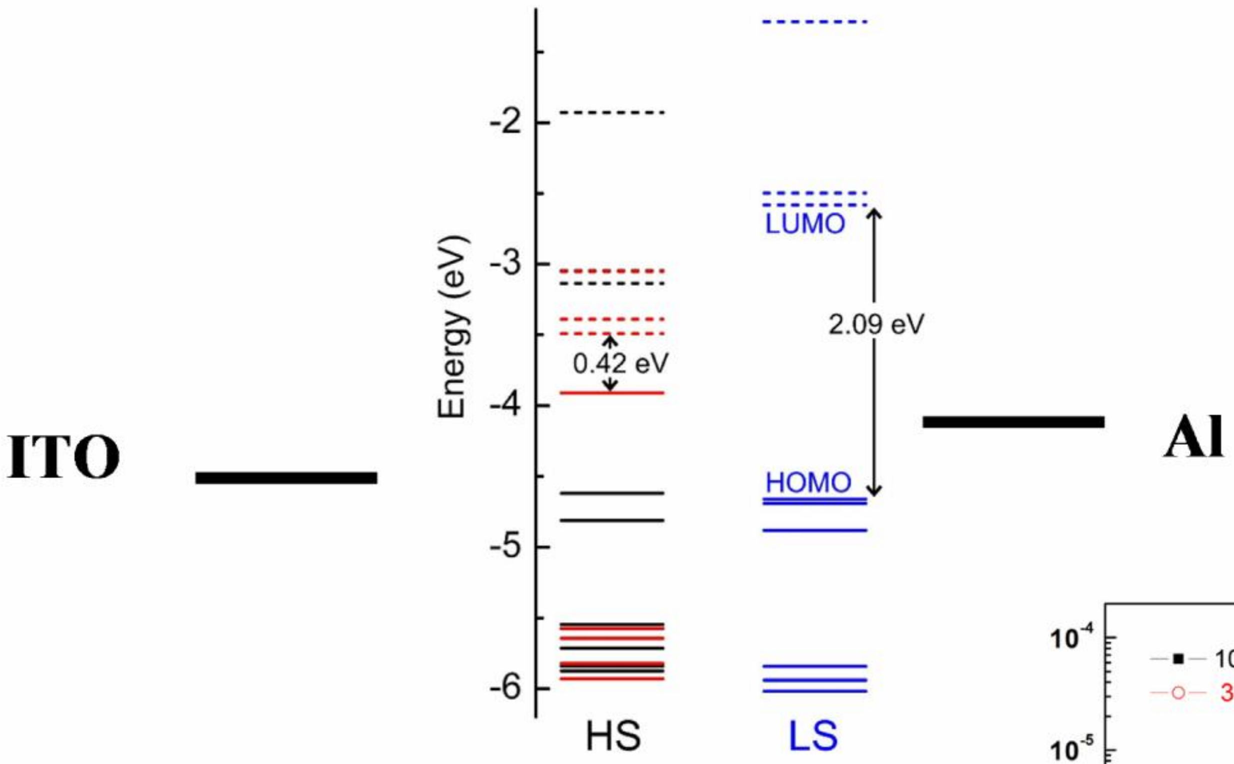
Multistep tunneling – LS state more conducting (higher hopping rate).

30 nm thick junction of $[Fe(H_2B(pyrazolyl)_2)_2(phen)]$



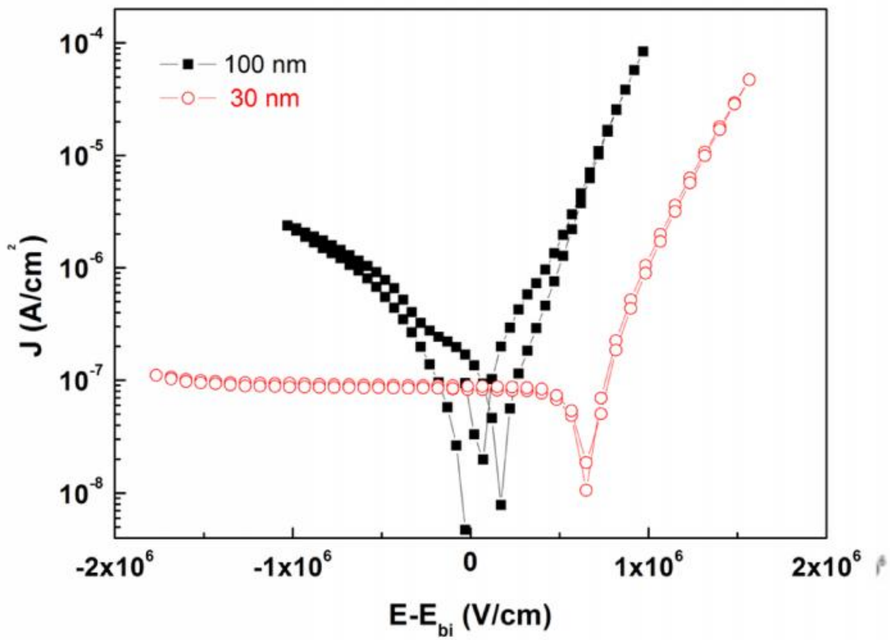
Adv Mater 2016, 28, 7508

Injection vs. bulk limited device



Angew. Chem. Int. Ed. 2012, 51, 6262

Bulk-limited transport –
LS state more conducting



Adv Mater 2016, 28, 7508

CONCLUSIONS / PERSPECTIVES

- Materials: low loss materials, hopping rates higher in the LS state

  - Prussian blue analogues (lack of films with SCO)

  - high Tc SCO complexes

  - <u>hybrid materials/devices with synergistic properties</u>

- Devices:
  - <u>Vertical junctions</u>: might be a BREAKTRHOUGH, but we need films with
    - high Tc SCO
    - more abrupt SCO
    - interface engineering

  - Planar devices: easier fabrication …… lower current intensity
  - Spintronic devices – need for magnetotransport measurements