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What is InnovationLab?

InnovationLab is an application-oriented platform for research and knowledge transfer in science and business supported by the University of Heidelberg, the Karlsruhe Institute of Technology and by the industrial partners BASF SE, Merck KGaA, Heidelberger Druckmaschinen AG and SAP SE.

Institutions involved:



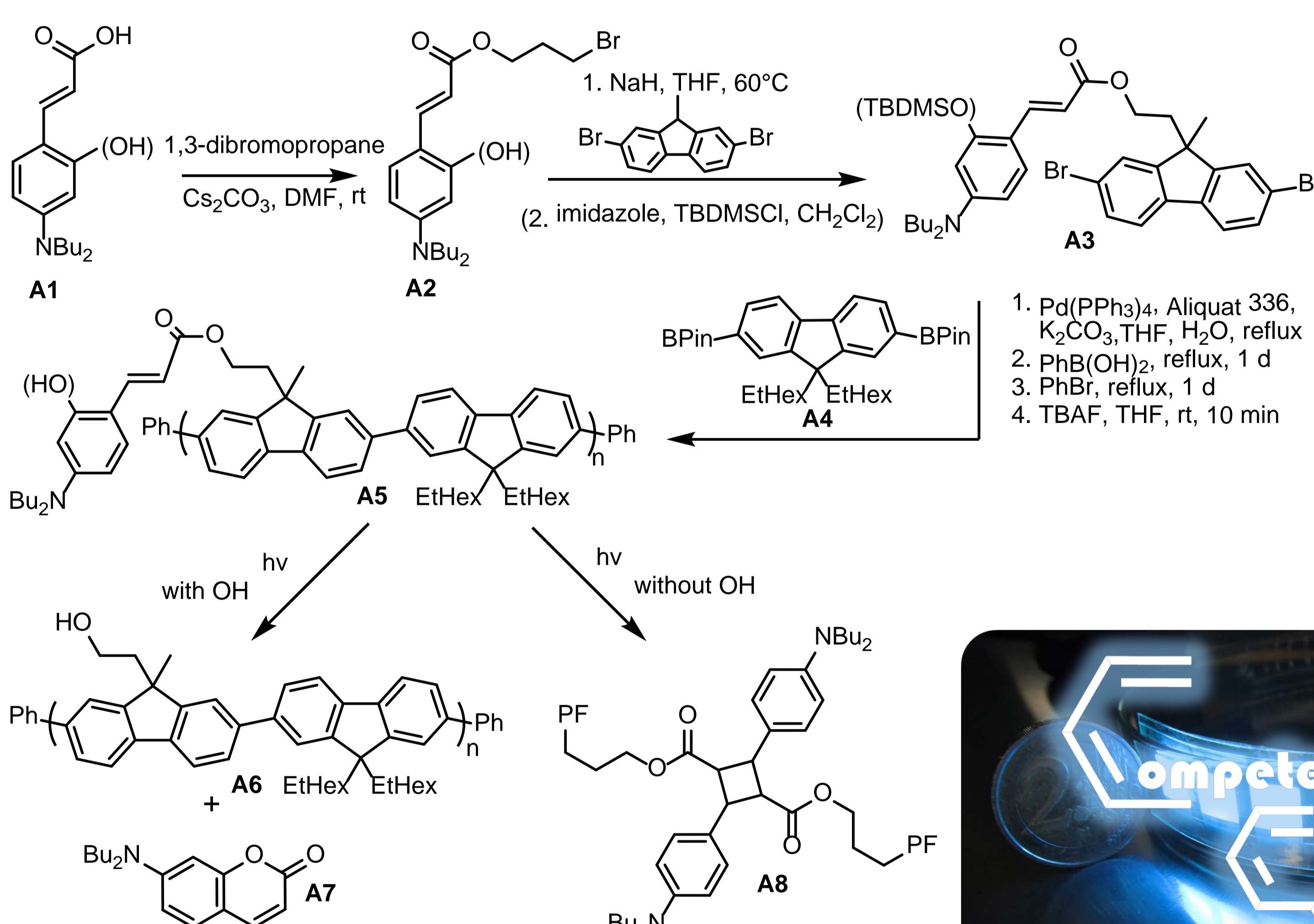
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Concept:

Early stage researchers from academia work hand-in-hand with researchers from industry and diverse disciplines. We develop materials utilized in OE for large-area solution processes like printing. By feeding back insights from processability studies into the synthesis the material properties can be tuned. Latest device performance data are utilized to immediately improve the next generation materials and thus speed up feed-back loops. In this way, tailor-made materials for solution processing are realized in the labs of the Institute for Organic Chemistry of Heidelberg University.

Solubility switchable semi-conducting polymers

For cost-efficient fabrication of OE-based devices, high-throughput processes like printing are required. However, the fabrication of consecutive layers from solution is challenging, as each layer has to be resistant to the solvent used for the next layer. Cleavage of solubilizing groups and cross-linking are demonstrated as suitable methods.^[1,2]



Scheme 1: Synthesis of cleavable or cross-linkable polyfluorene (PF) **A5** and insoluble PFs **A6** and **A8**.

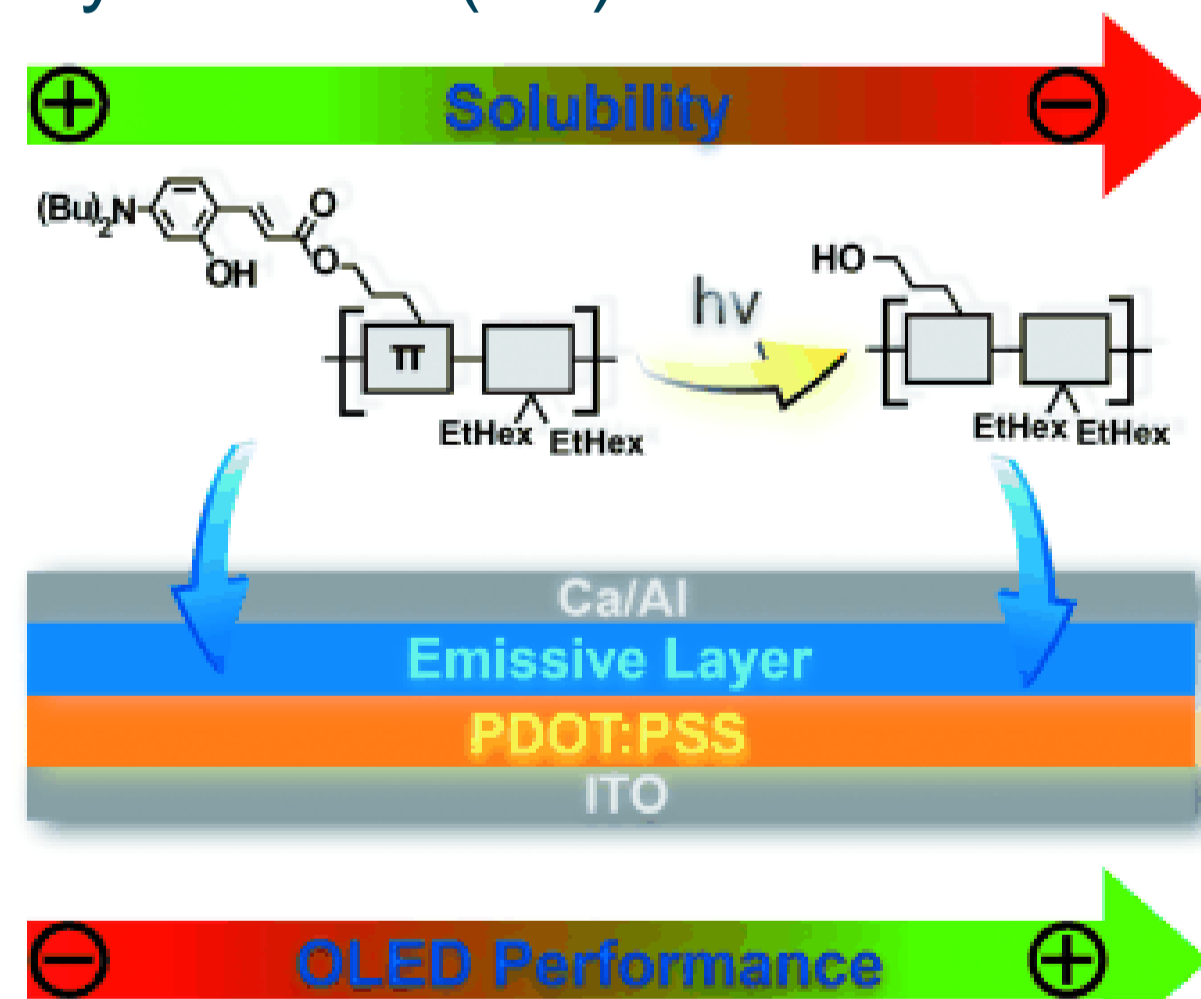


Figure 1: Schematic cleavage process.

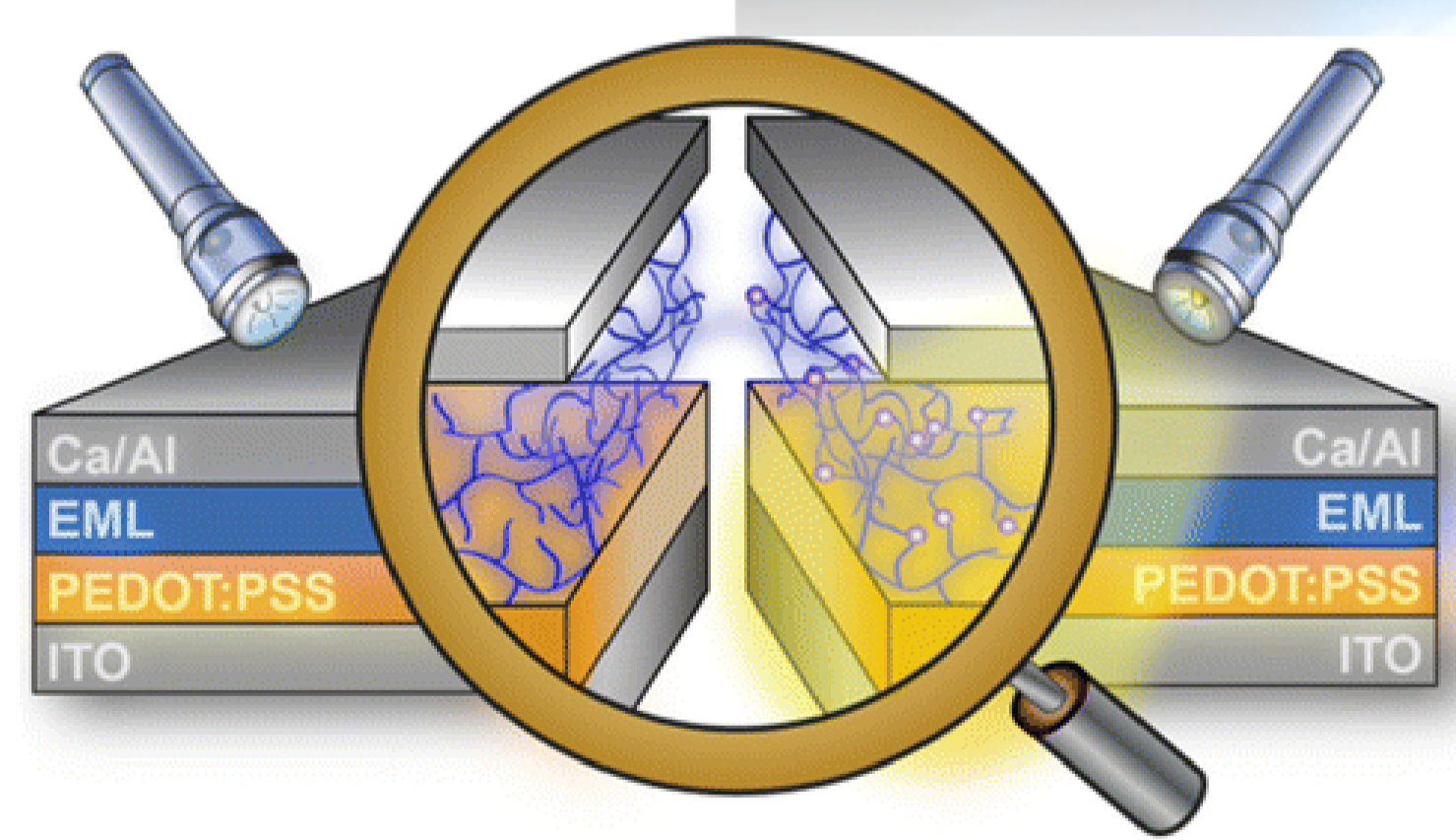
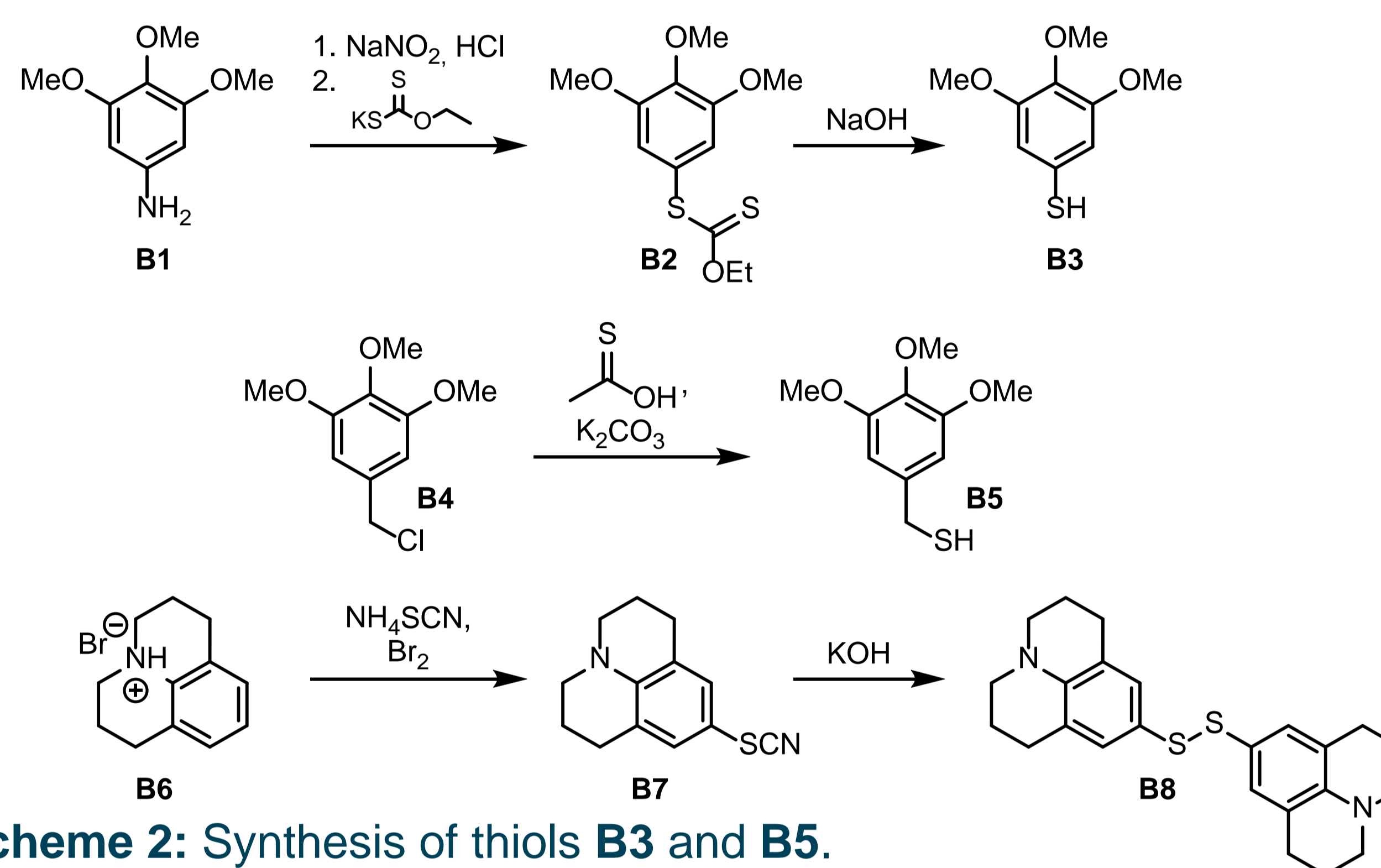


Figure 2: Schematic cross-linking of emissive layer in an OLED.

A decreased solubility is achieved with both strategies, however cleavage of solubilizing groups is unfavorable since it's leaving fragments in the film which might act as charge traps. Additionally the use of UV light to switch the solubility could lead to degradation of the active material. Thus, our current research is focused on the synthesis of thermally cross-linkable materials.

Modification of electrode work-function via SAMs

Small conjugated molecules can, as self-assembling monolayers (SAMs), shift the work function of gold to n-channel semiconductor regimes as well as improve the wettability of the surface.^[3,4]



Scheme 2: Synthesis of thiols **B3** and **B5**.

#	μ [Db]	$\Delta\Phi$ [eV]
B3	1.48	-0.43
B5	1.42	-0.31
B8	4.20 (monosulfide)	-1.18

Table 1: Calculated dipole moments and reduction of gold work function (XPS/UPS).

Whereas compounds **B3** and **B5** are stable in their monomeric form, dimeric **B8** dissociates *in situ* prior to binding to the noble metal surface. Contact resistances in OFETs are reduced by 2-3 orders of magnitude, whereas wettability is increased, thus facilitating solution processing of a subsequent layer. When changing from gold to silver, immersion time is rapidly reduced from 2 h to 1 min for **B8**.

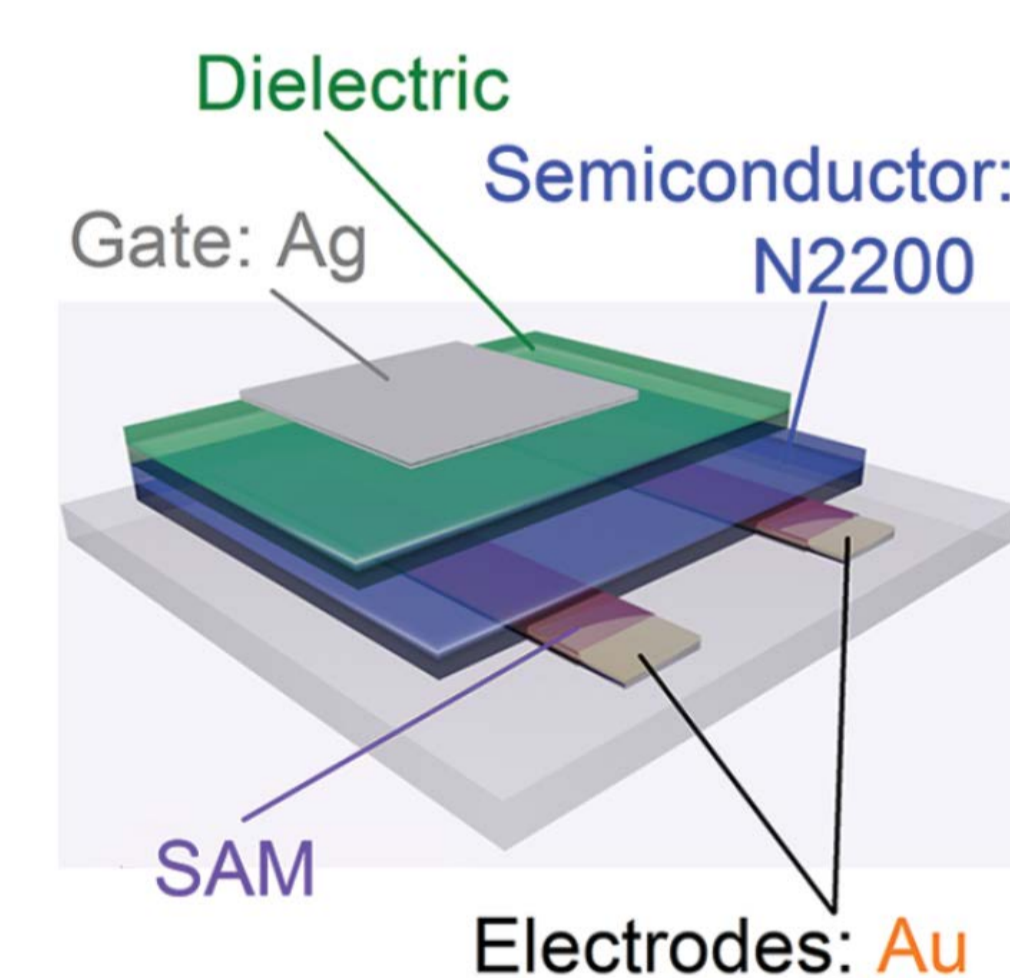


Figure 3: Transistor architecture employed.

As the change in work function is predominantly dependent on the dipole moment perpendicular to the surface, our further studies will aim orthogonal orientation of the dipoles employing a multidentate platform approach for SAM formation.

References:

- [1] *Macromolecules* **2016**, *49*, 1518-1522.
- [2] *Angew. Chem. Int. Ed.* **2015**, *54*, 14545-14548.
- [3] *Langmuir* **2015**, *31*, 10303-10309.
- [4] *Adv. Funct. Mater.* **2016**, *26*, 3172-3178.

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