



# Transition metal complexes in electronics

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Seminar talk presented by

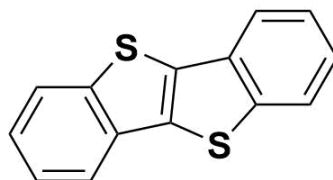
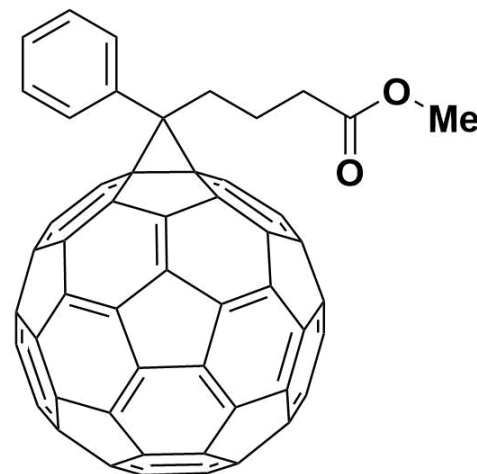
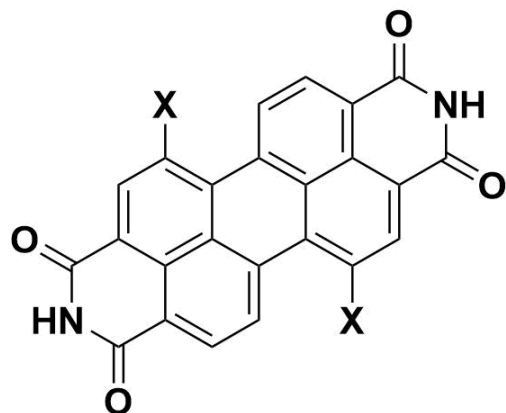
**Harald Locke**

June 8<sup>th</sup>, 2018

*Institute of Organic Chemistry*

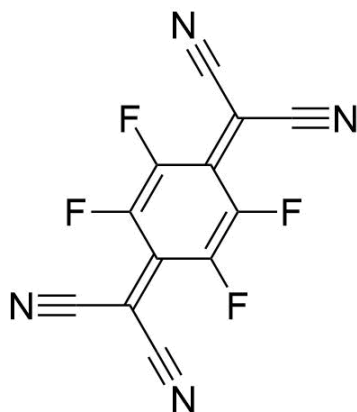
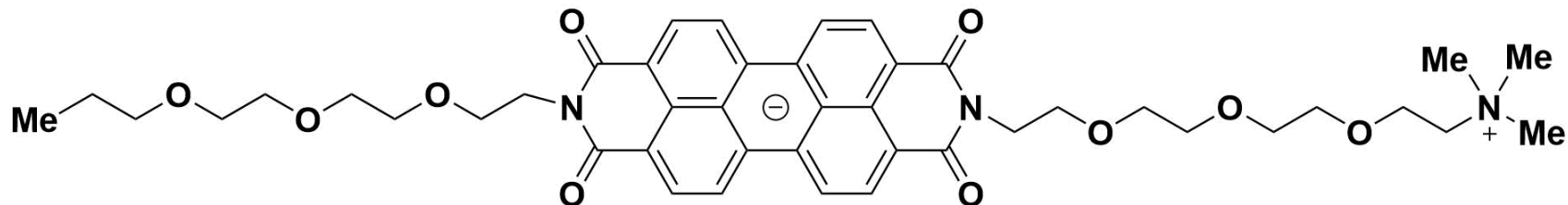
*Justus-Liebig University Giessen*

# Known organic semiconductors



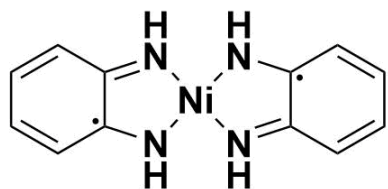
- Strong  $\pi$ -electron interaction
- carrier mobility depends
  - grain size
  - interaction strength

# Known organic semiconductors

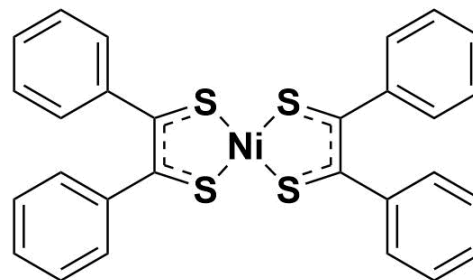


- Substitutions and doping is challenging
- Intrinsic doping with air

# Nickel-based semiconductors

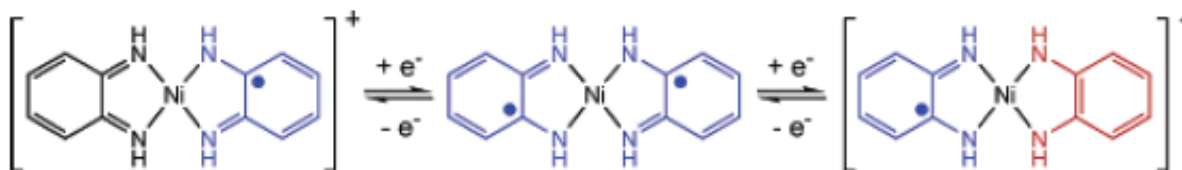


n-type

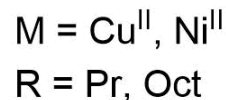
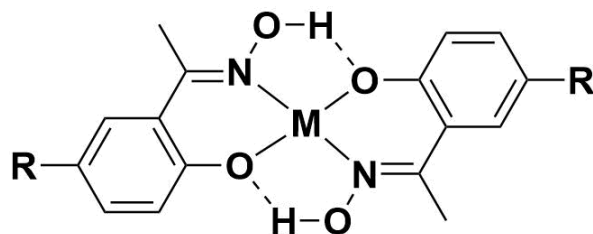


p-type

- Planar metal complexes
- High redox activity

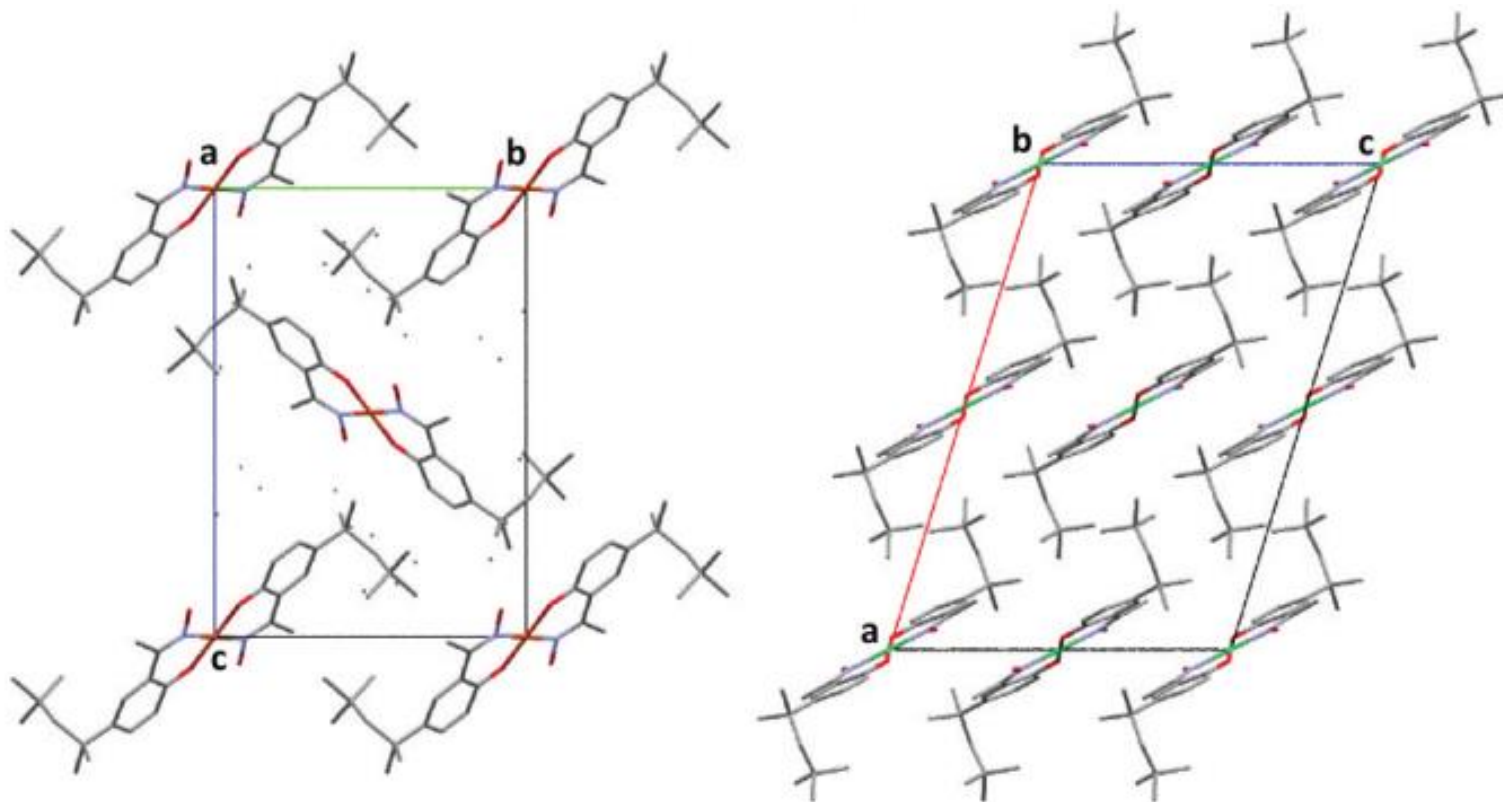


# Nickel-based semiconductors



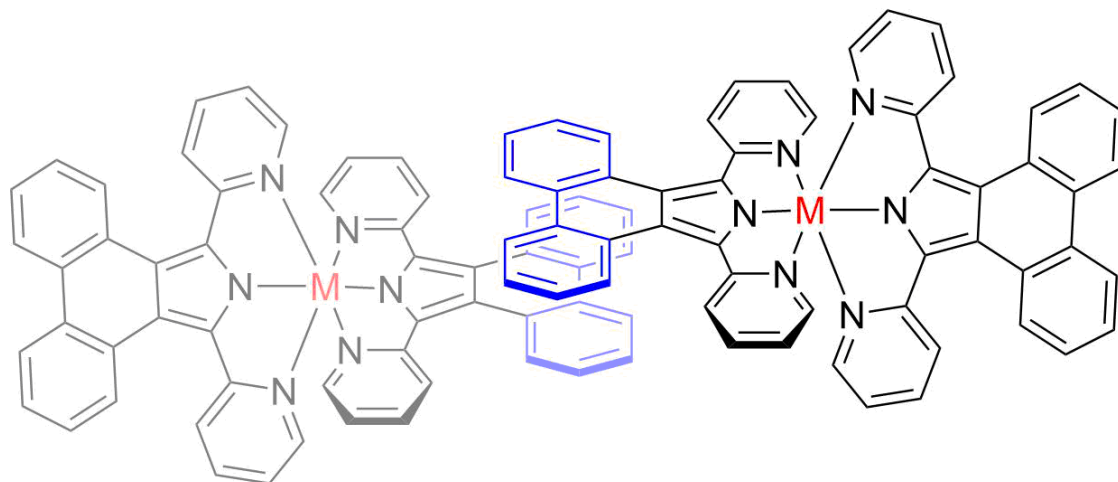
- Cu(II) and Ni(II) form square planar complexes
- Size of the metal center is similar as well

# Nickel-based semiconductors



- Complex geometry is very similar
- But orbital occupation is not

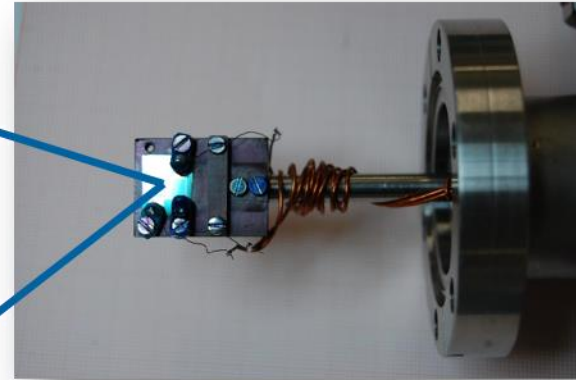
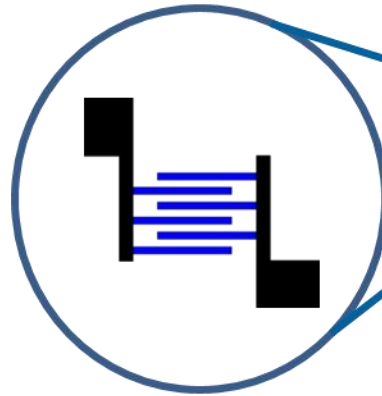
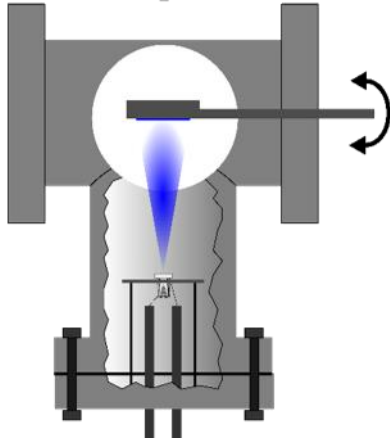
# Structural suggestion



M = Mn, Fe, Co, etc.

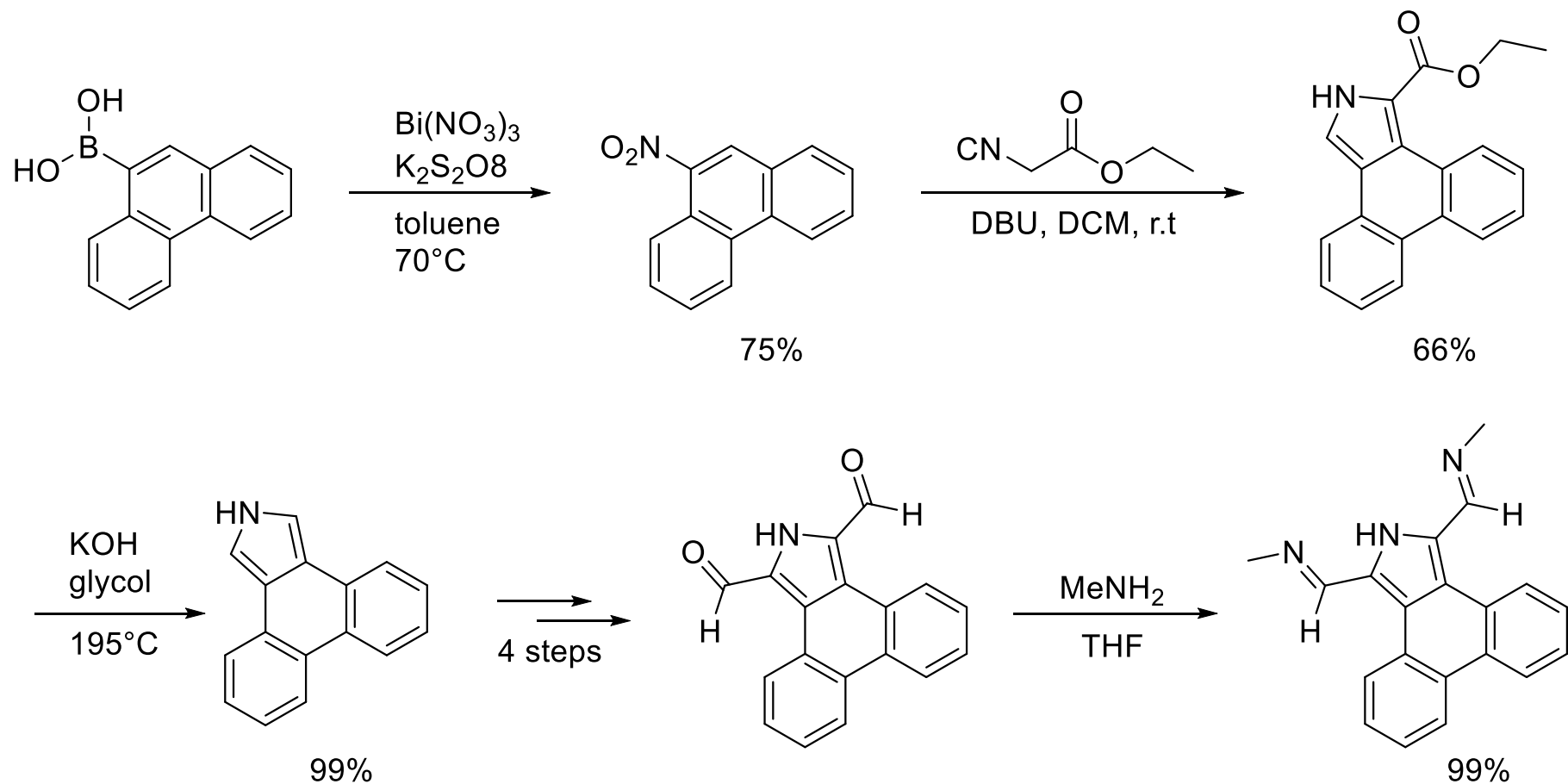
- Various metal possible to alter electronic properties
- Only small changes on cheometry after transmetallation

# Processing



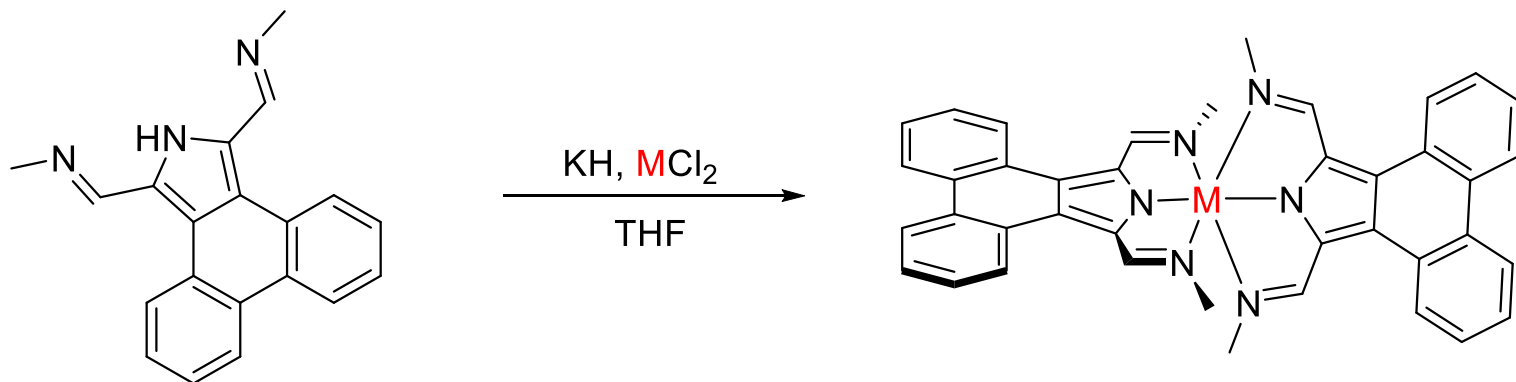
- Physical vapor deposition (PVD)
- Gold interdigital structures
- Bottom silicon gate

# First attempt



Time consuming, multi-step synthesis

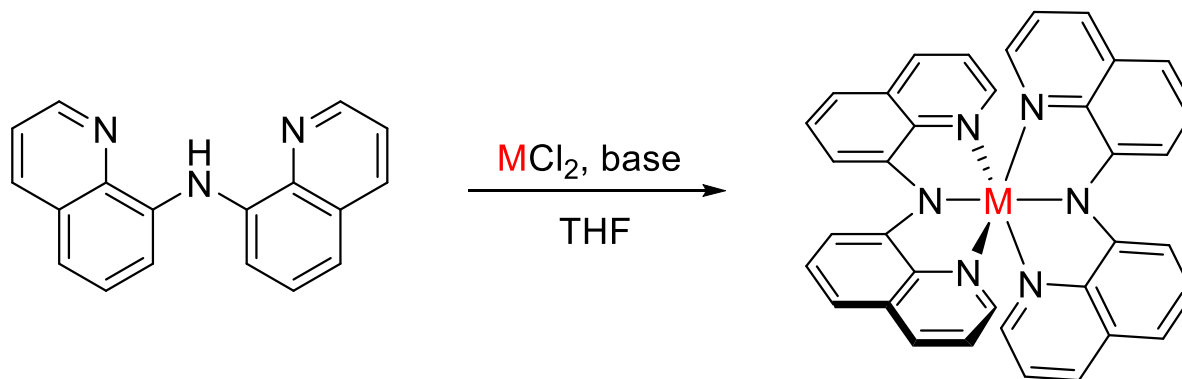
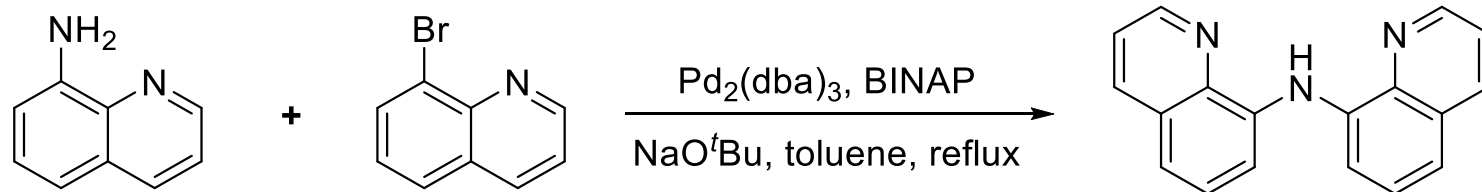
# First attempt



$\text{M} = \text{Zn}, \text{Fe}$

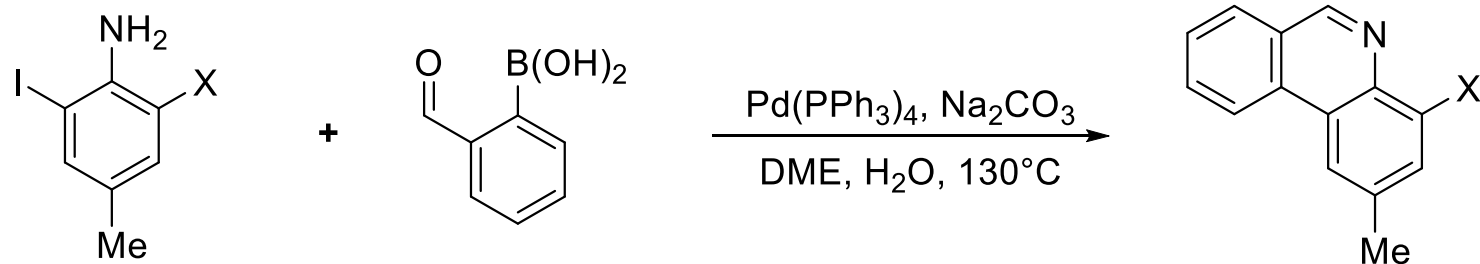
- Complexes were obtained
- But not stable under conditions of PVD

# Second attempt

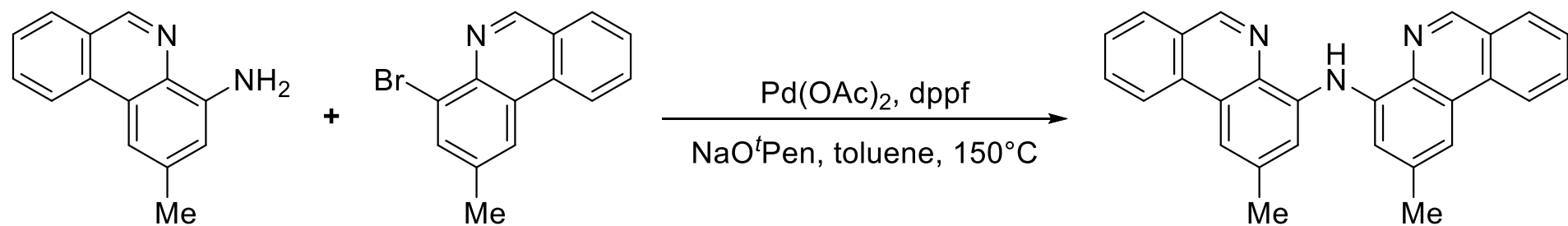
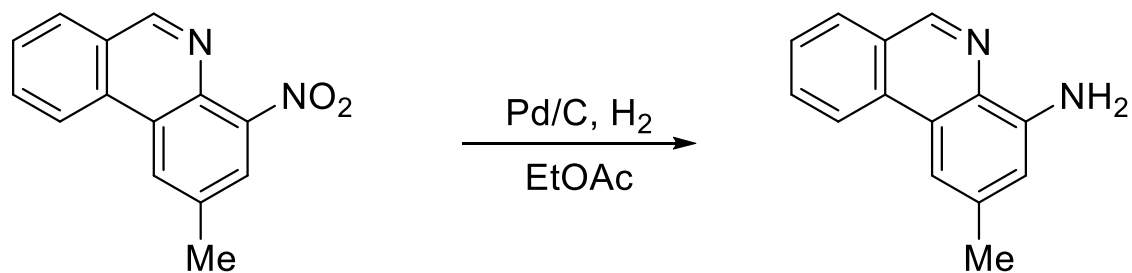


- Quick synthesis
- Derivatives are also easily accessible

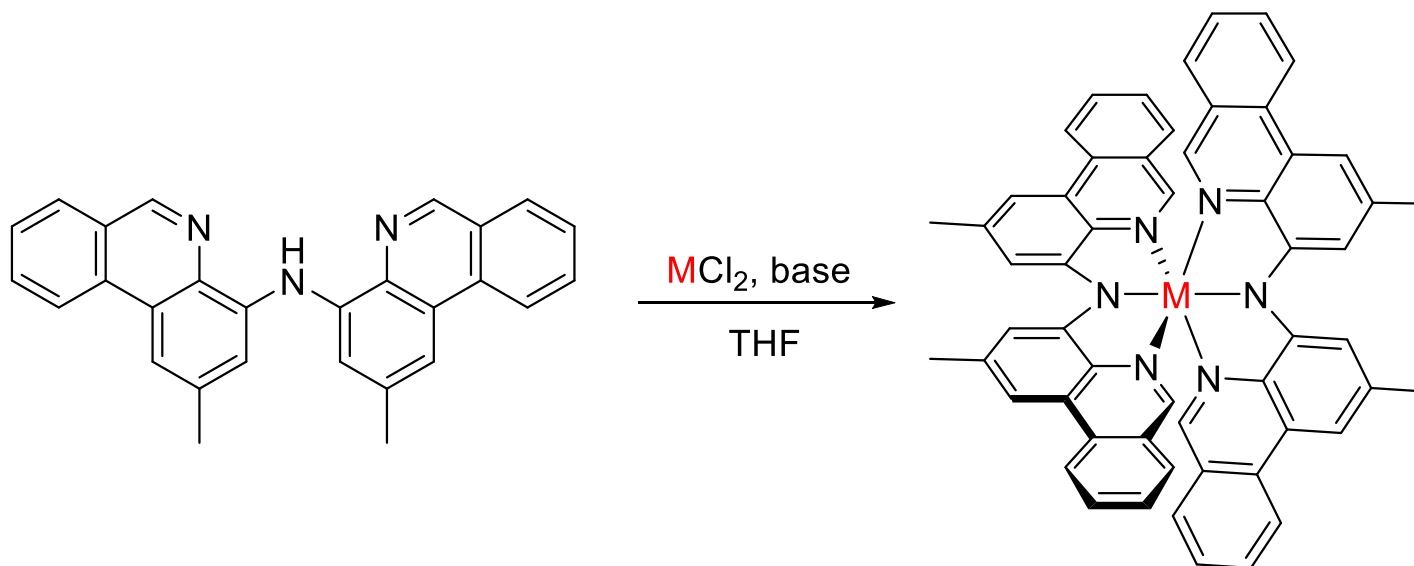
# Second attempt



X = Br, NO<sub>2</sub>

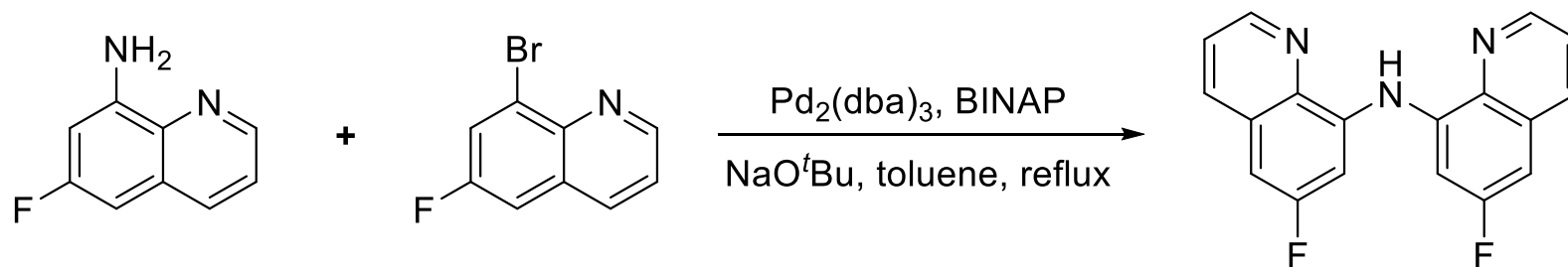
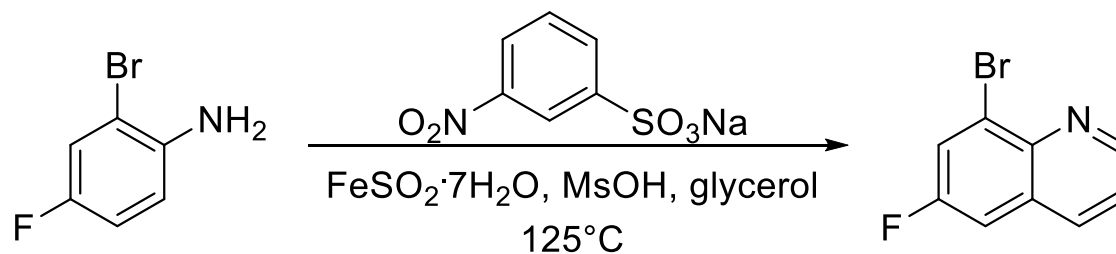
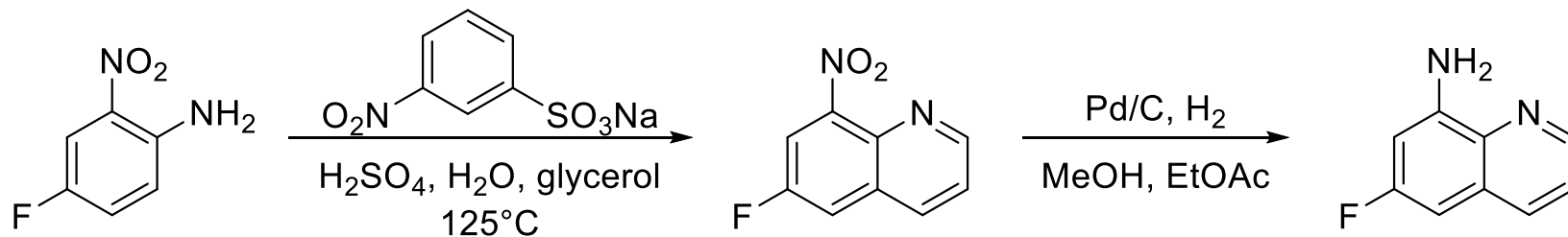


# Second attempt

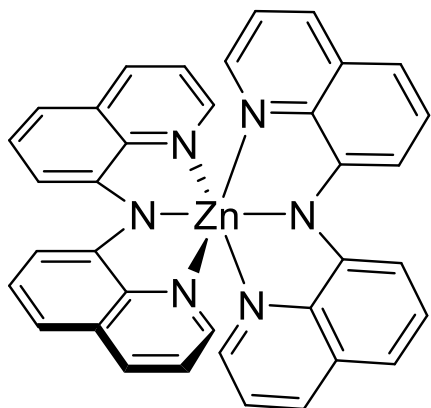


- Same procedure possible
- But conversions tend to be lower
- And work-up more complicated

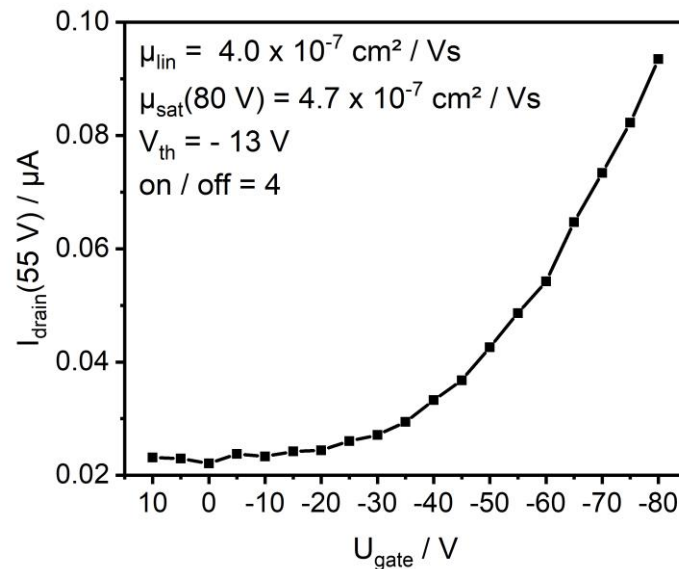
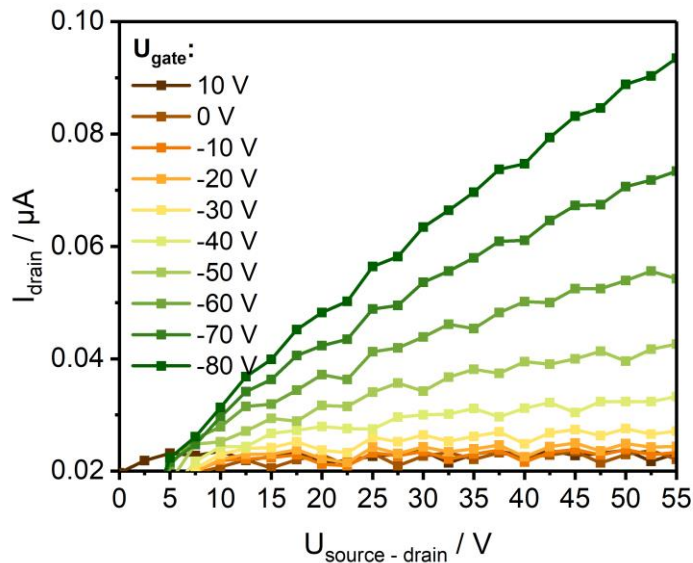
# Second attempt



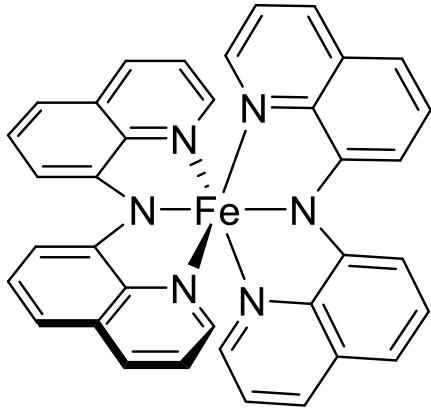
# Zinc BQA complex



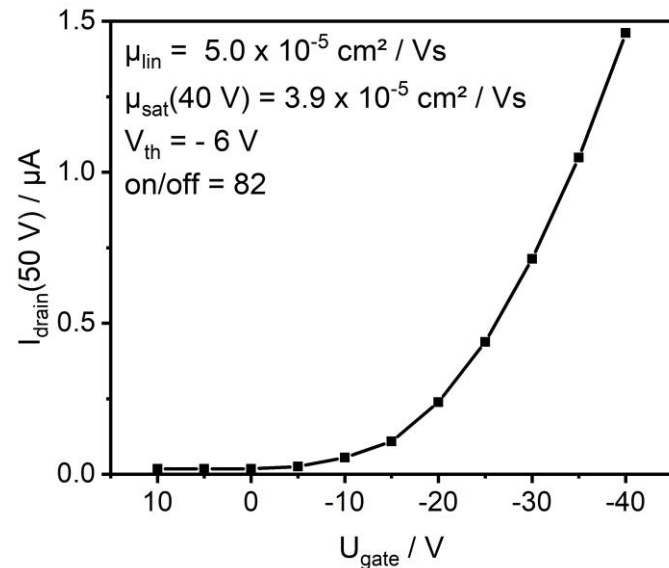
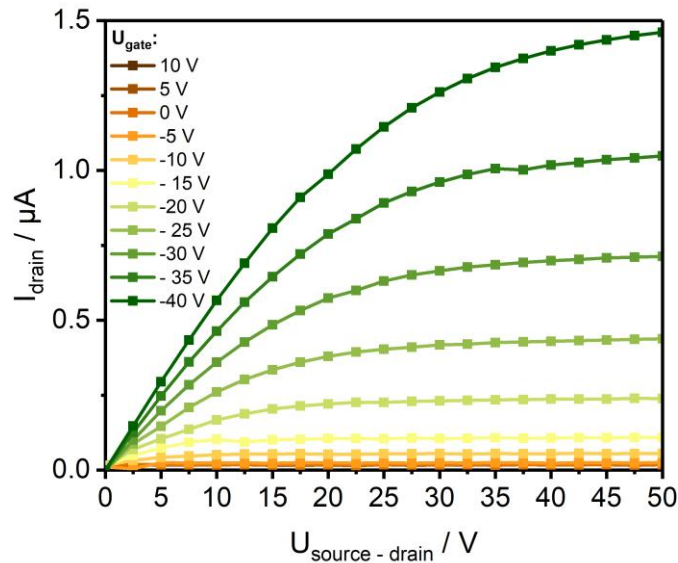
- Low charge mobility device
- Stable under air



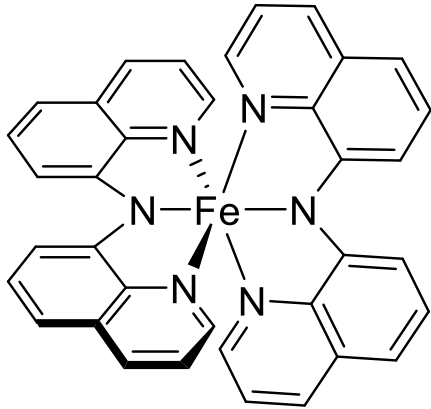
# Iron BQA complex



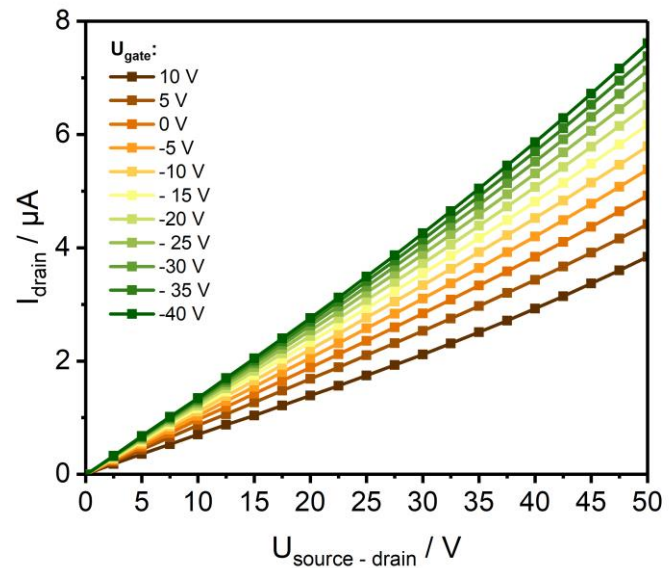
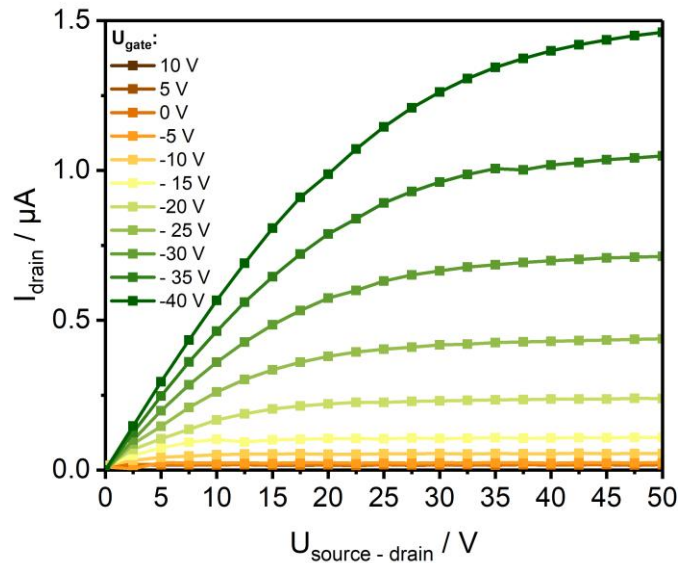
- Medium charge mobility device
- Probably hole transport



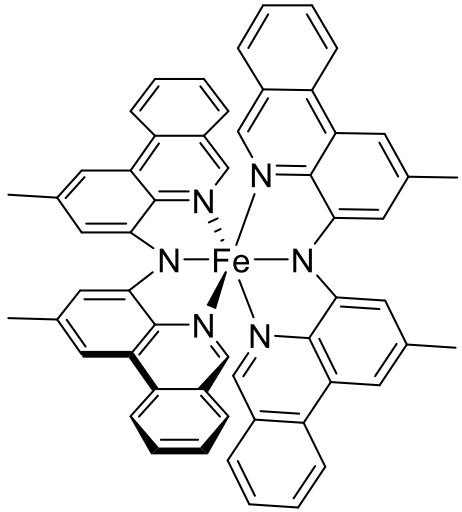
# Iron BQA complex



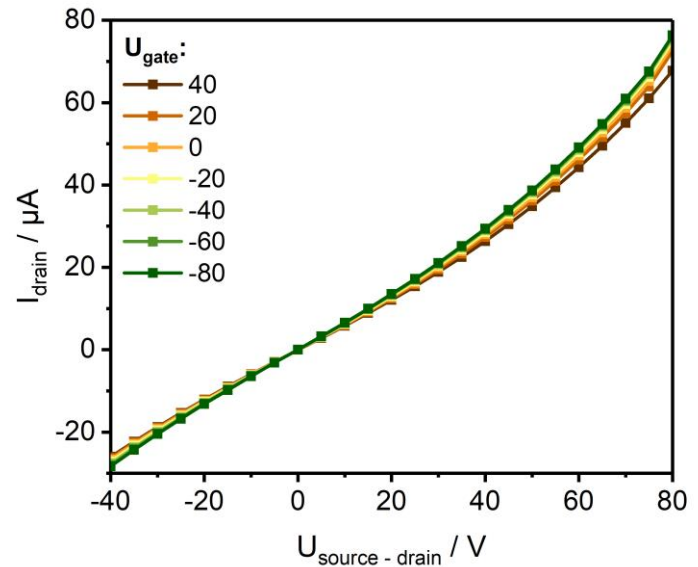
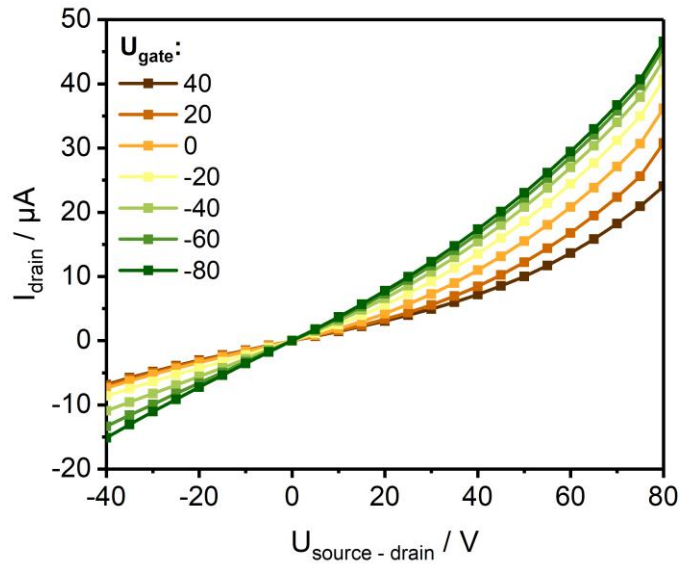
- After air exposure the current is increased
- Conductivity becomes rather “metal-like”



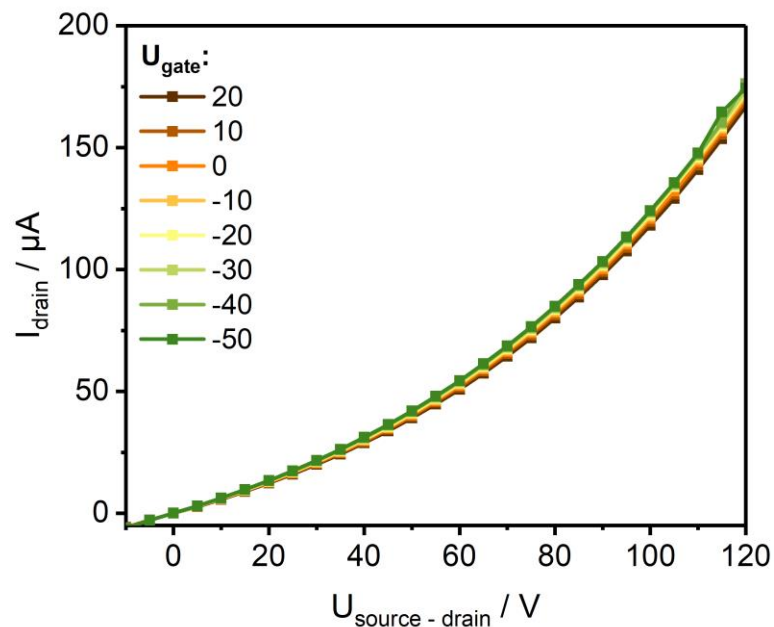
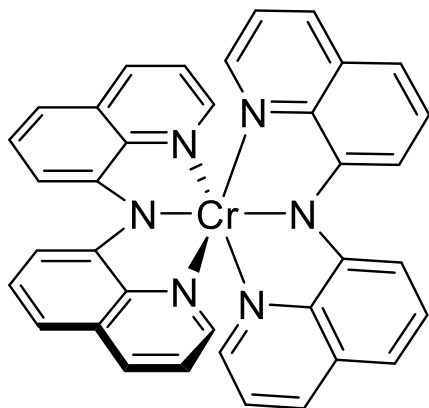
# Iron BPA complex



- The influence of the gate voltage is rather low
- And its influence vanishes upon air exposure



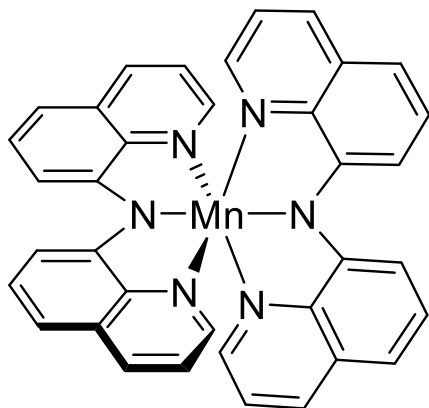
# Chromium BQA complex



- Quite high currents
- No field effect visible
- No current after air exposure

# Manganese BQA complex

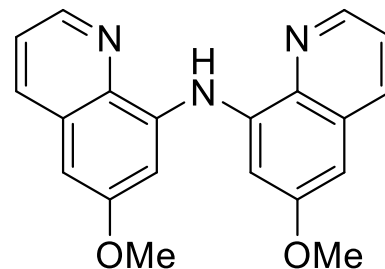
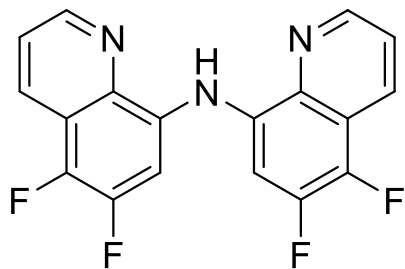
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- On several tries no current was measurable
- Lower detection limit: 500 pA
- Not useful

# Outlook

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- Synthesize more derivatives
- Characterize all complexes
- Test devices with all complexes
- Synthesize also all Cobalt complexes





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**Thank you for  
your kind attention!**