Poly(*p*-phenylen vinylene)s:

Highlights of 12 years of research within the SFB 595

TECHNISCHE UNIVERSITÄT DARMSTADT

SFB 595 Deutsche Forschungsgemeinschaft DFG

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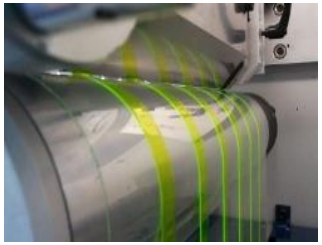
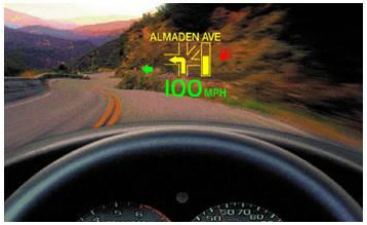
Osram Opto Semiconductors GmbH

www.schott.com

Samsung F9500-OLED-TV



www.plusplasticelectronics.com



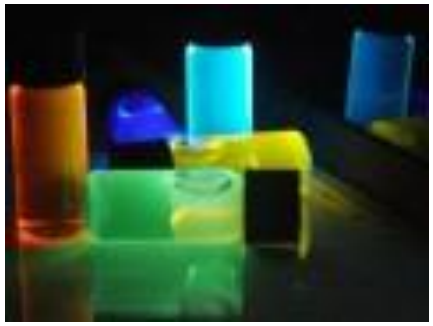
N.S. International Ltd. head-up display

Lumiblade-Panel GL 350

Motivation

Polymer-based organic light emitting diodes (OLEDs)

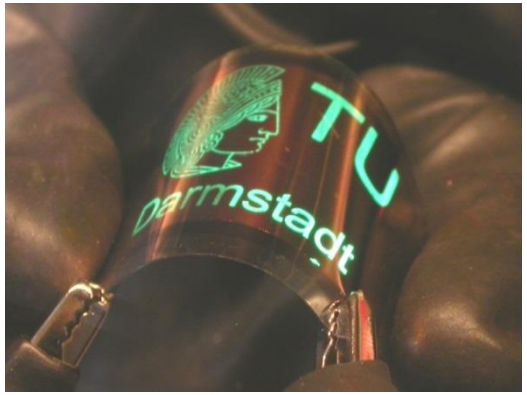
suffer from insufficient



life-time

color stability

efficiency



therefore we started to investigate…

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We started to investigate…

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… different monomer and polymer structures.

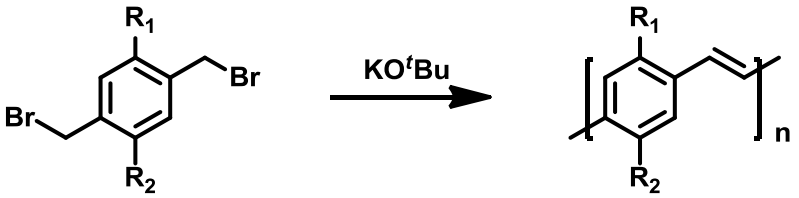
… polymerization mechanisms.

… the defect structures in PPVs.

… the influence of different strategies to modify emission color in PPVs.

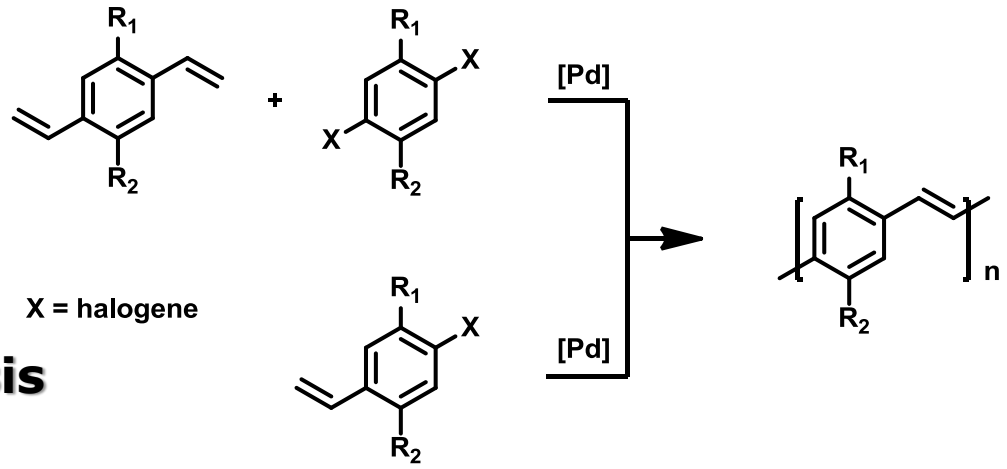
… the morphology and thermal behavior of PPVs.

Monomer and Polymer Structures

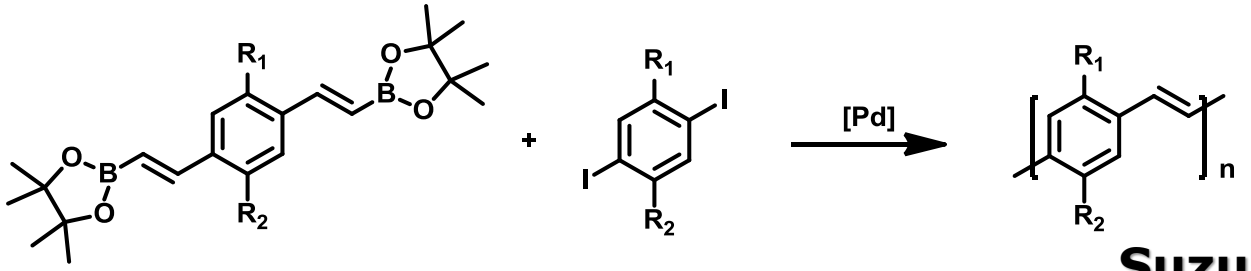


Gilch polymerization

$R_1 = R_2 = H$
$R_1 = R_2 =$ (2'-ethylhexyloxy)-
R_1 = methoxy-; R_2 = (2'-ethylhexyloxy)-
R_1 = methoxy-; R_2 = (3',7'-dimethyloctyloxy)-
R_1 = propoxy-; R_2 = (2'-ethylhexyloxy)-



Heck synthesis

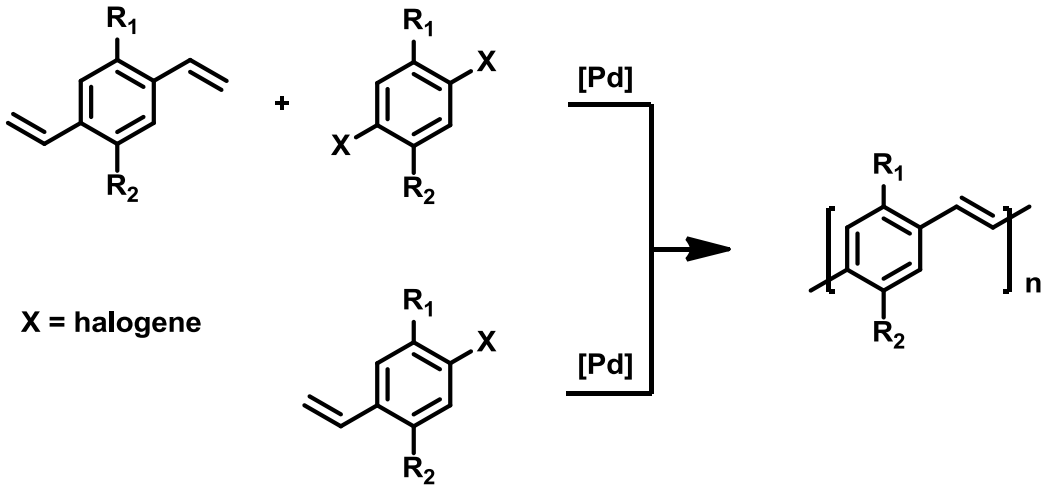


Suzuki polycondensation

The Heck synthesis

In the beginning:

The Heck synthesis lead to "oligomeric" materials only!

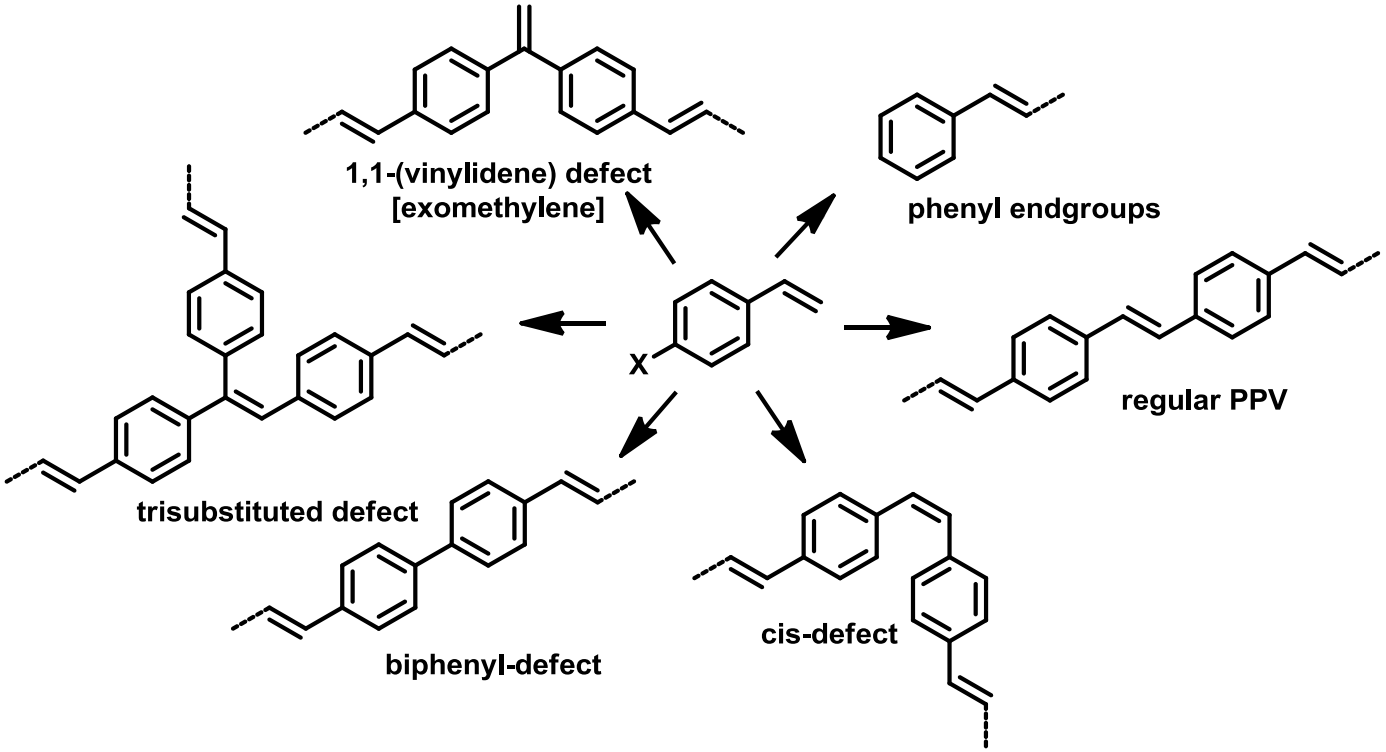


In the end:

High molecular weight materials were received using

- **An optimized Pd-based catalyst system**
- **Monomers that contain solubility improving lateral substituents**

The Heck synthesis: Constitutional defects

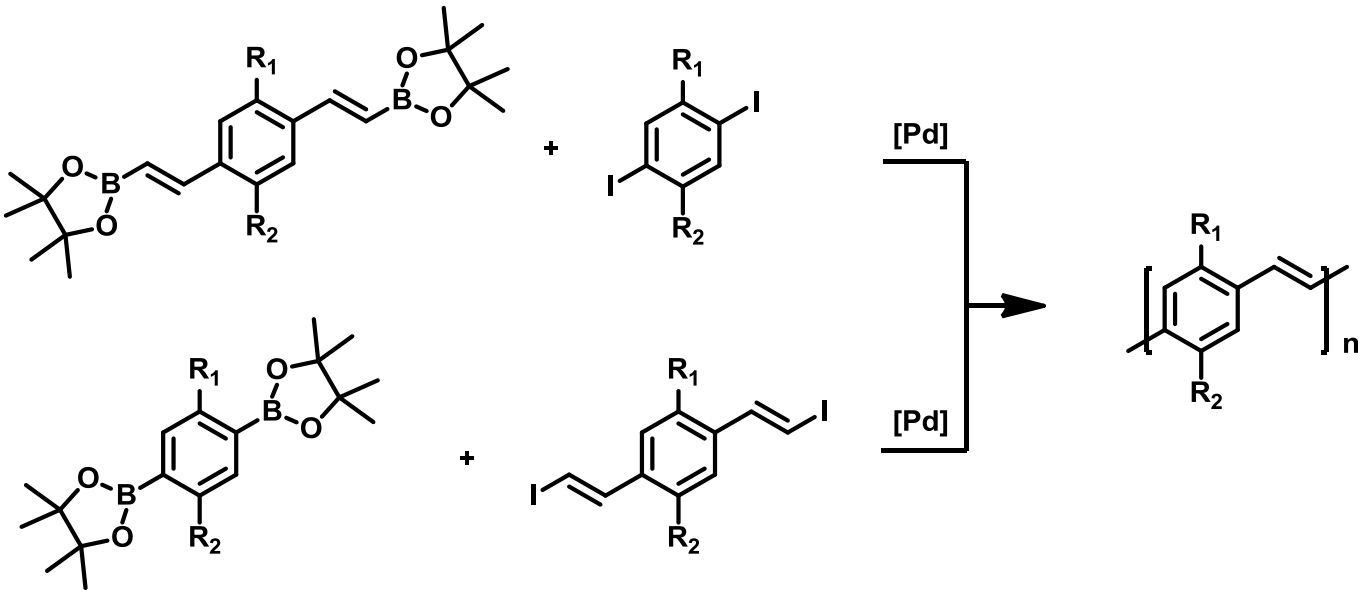


While the obtained molar masses could be improved, the formation of constitutional defects increased!

The Suzuki polycondensation

In the beginning:

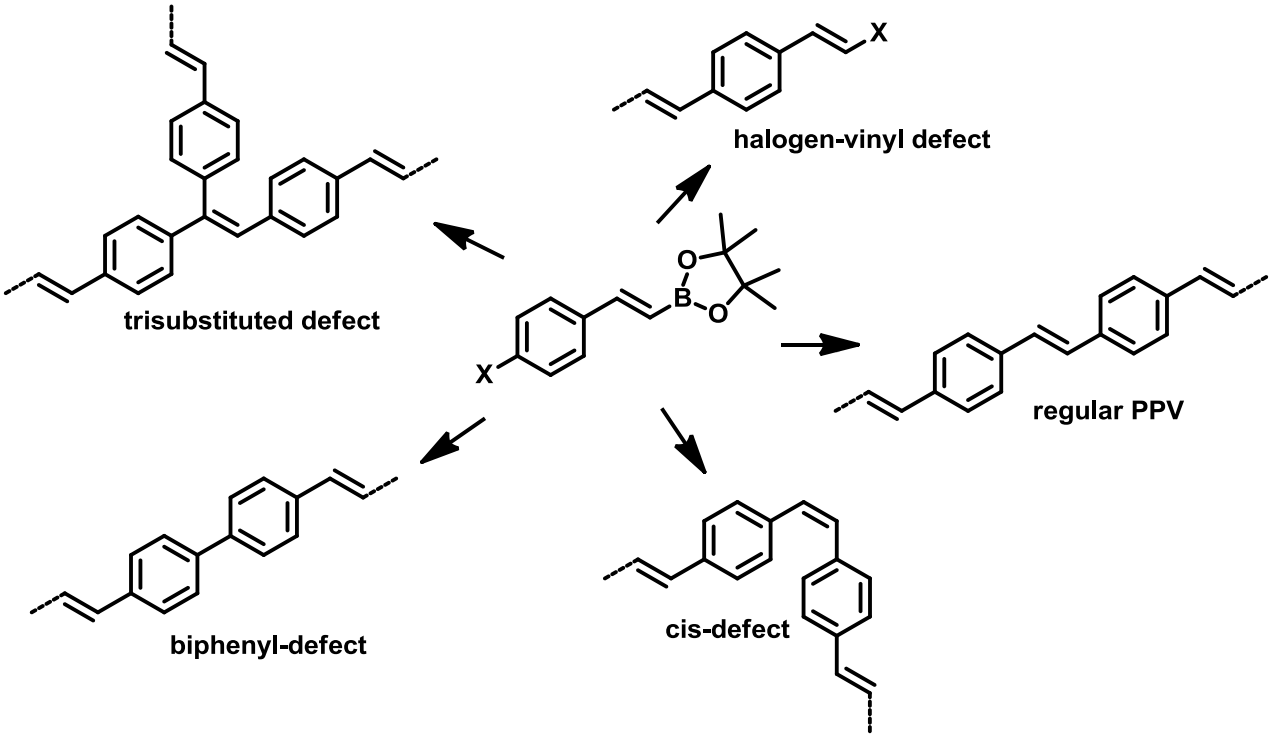
The Suzuki polycondensation lead to "oligomeric" materials only!



In the end:

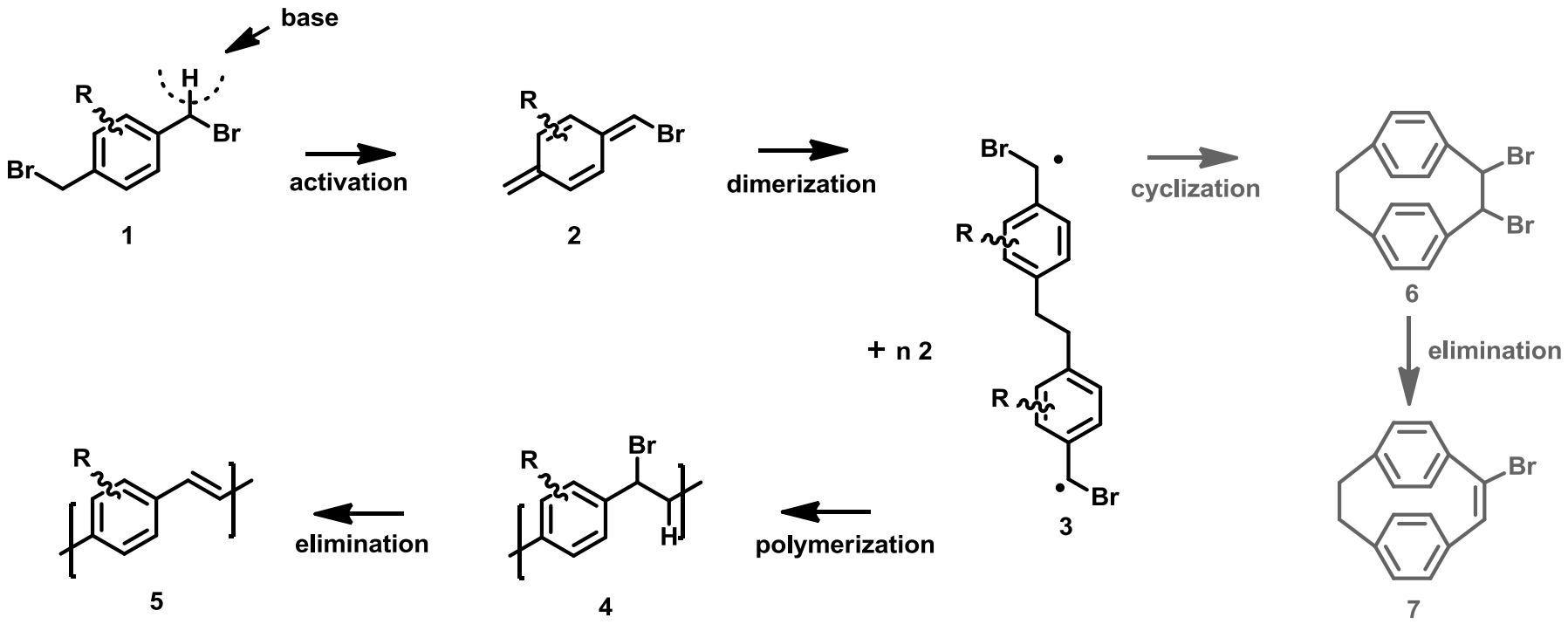
The Suzuki polycondensation results in high molecular weight materials but...

Suzuki polycondensation: Constitutional defects



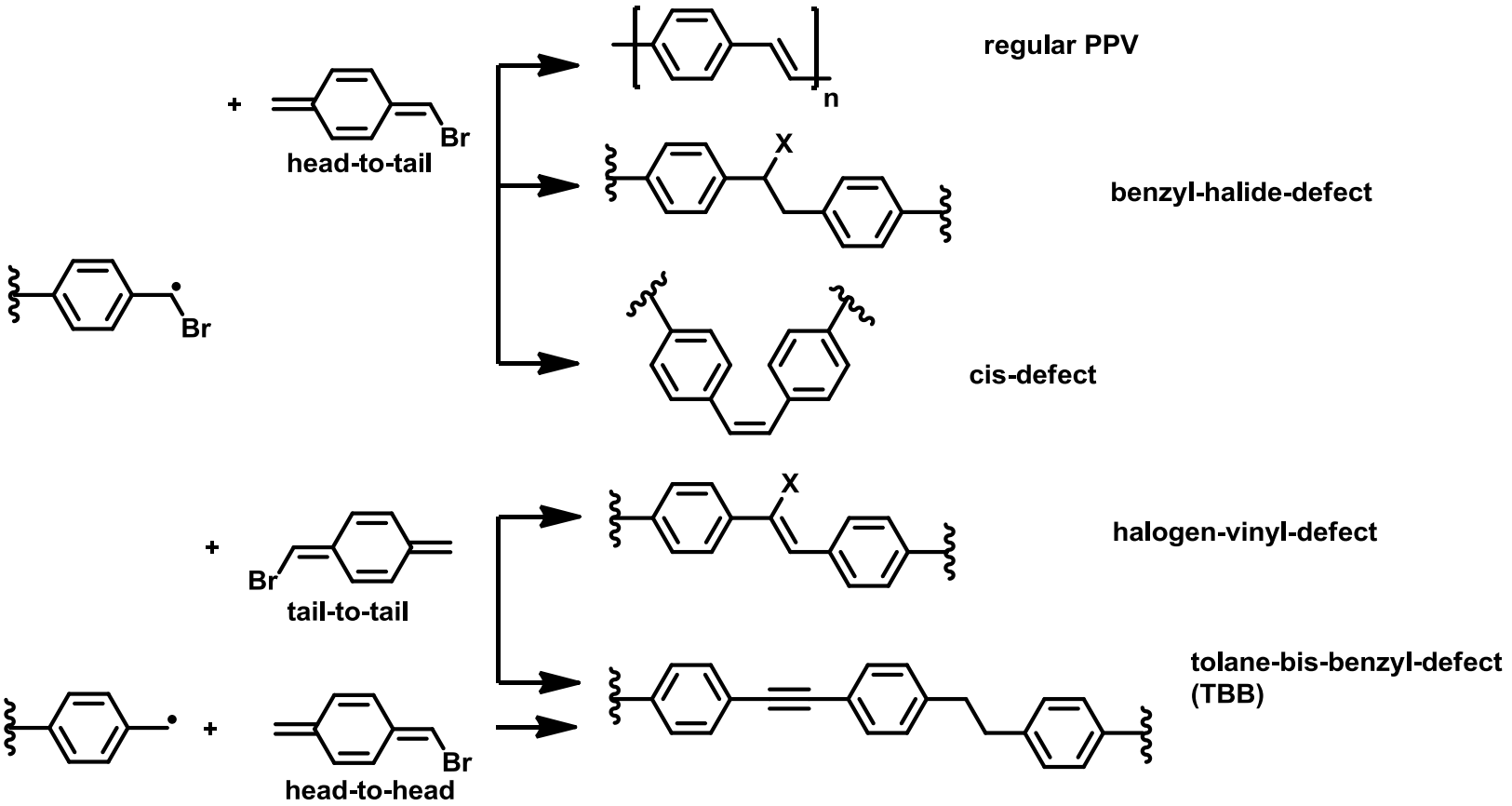
… the formation of constitutional defects could not be controlled completely!

The Gilch polymerization

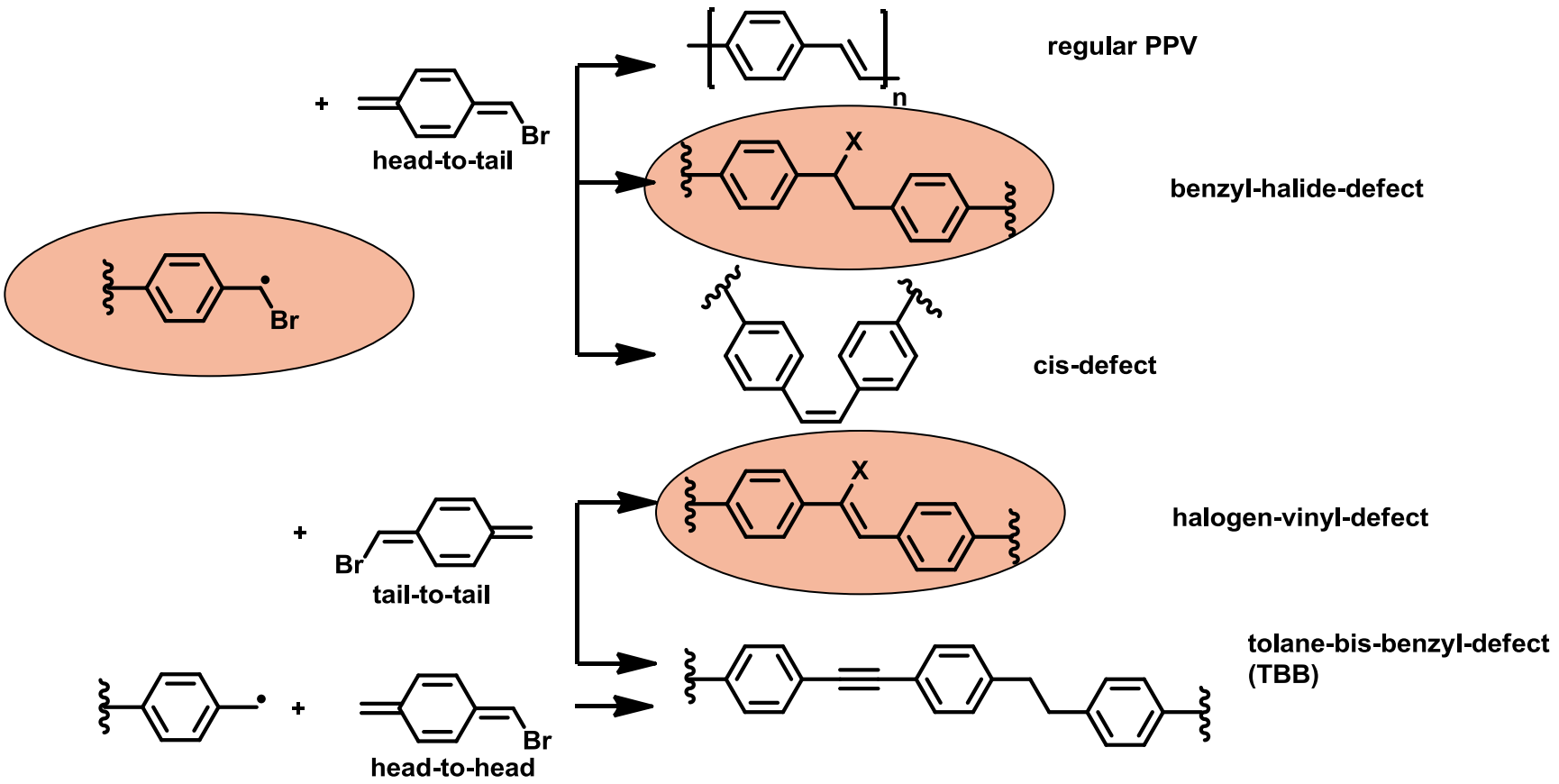


The standard Gilch process is a radical chain growth polymerization, initiated by diradical 3.

The Gilch polymerization: Constitutional defects

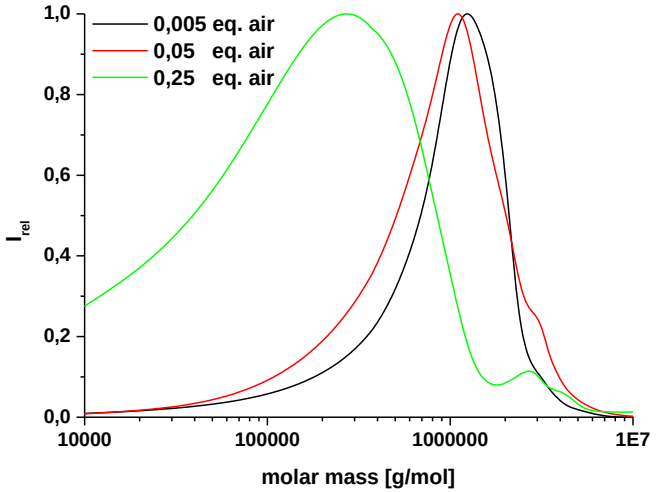


The Gilch polymerization: Constitutional defects

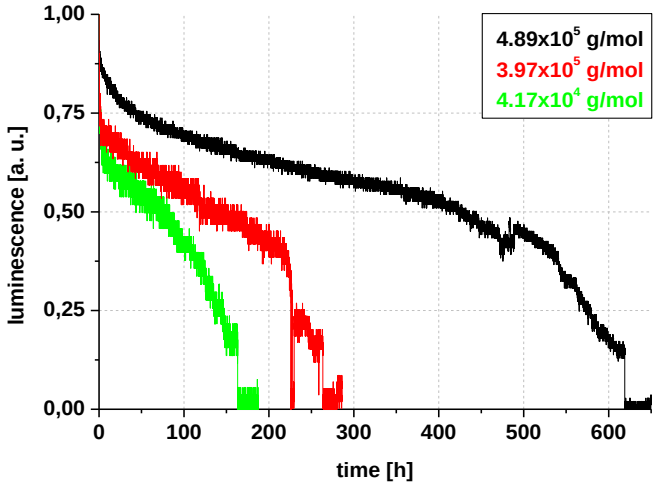


Molar mass control

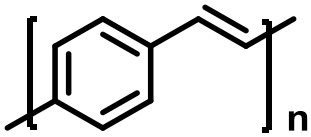
Addition of oxygen shortly before the polymerization process leads to reduced molar masses of PPVs.

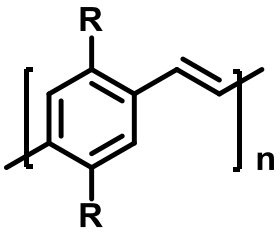


Light-emitting-devices based on low molar mass PPVs tend to fail at efficiency and life-time very fast.



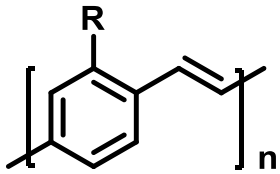
Influence of lateral substituents on the emission color



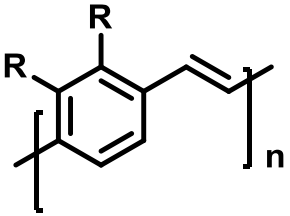


R = (2-ethylhexyloxy)-
[orange-red emission]

R = (2-ethylhexyl)-
[green emission]



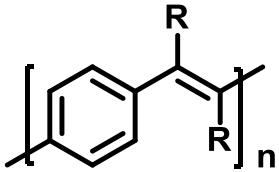
R = (dendritic system)-
[green emission]



R = (2-ethylhexyloxy)-
[green emission]

R = tricyclic-
[green emission]

R = dendritic system-
[blue-green emission]



R = phenyl-
[not applicable]

R = alkyl-
[no polymer]

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Highlights

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We were able to …

- **… optimize molar masses for PPVs synthesized via the Heck and Suzuki process.**
- **… clarify the nature of the Gilch mechanism.**
- **… investigate the origin of constitutional defects in Gilch PPVs and their impact on OLEDs.**
- **… show that high molar masses are important in polymeric semiconductors.**
- **…modify emission color in PPVs by different strategies.**

Acknowledgement

- **All active members of the SFB 595**

  Matthias Rehahn
  Andrea Gassmann
  Valentina Rittscher
  Heinz v. Seggern

- **All former members of the SFB 595**

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  Arne Fleissner
  Jens Langecker
  Katja Stegmaier
  Thorsten Schwalm
  Christian Melzer
  Michael Preuß
  Helga Janning
  Gabi Andress

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SFB 595: Annual meeting 2010

Thank you
for your kind attention!