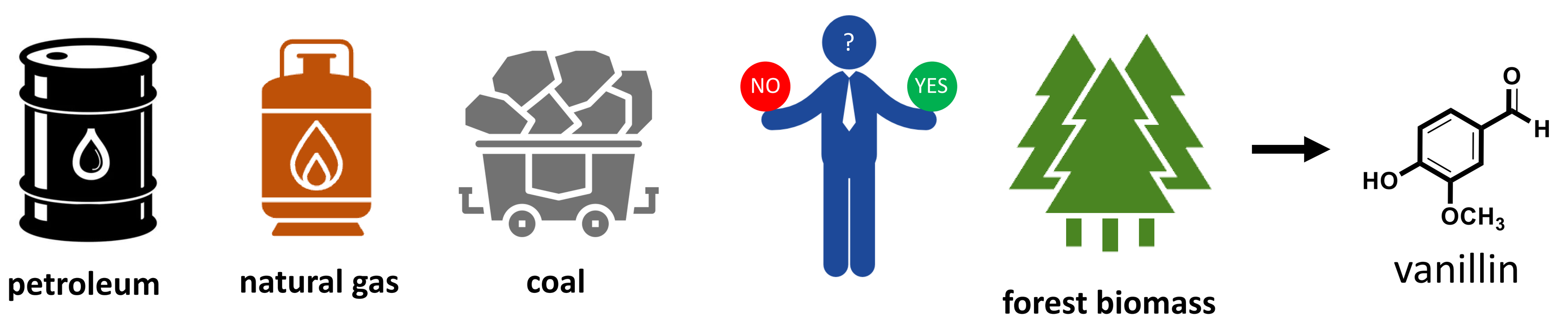
Vanillin-based heterocycles: Biosourced building blocks for organic electronics

Louis-Philippe Boivin[1], William Dupont[1], Jérémie Abran[2], Mario Leclerc[1] and David Gendron[1,2]

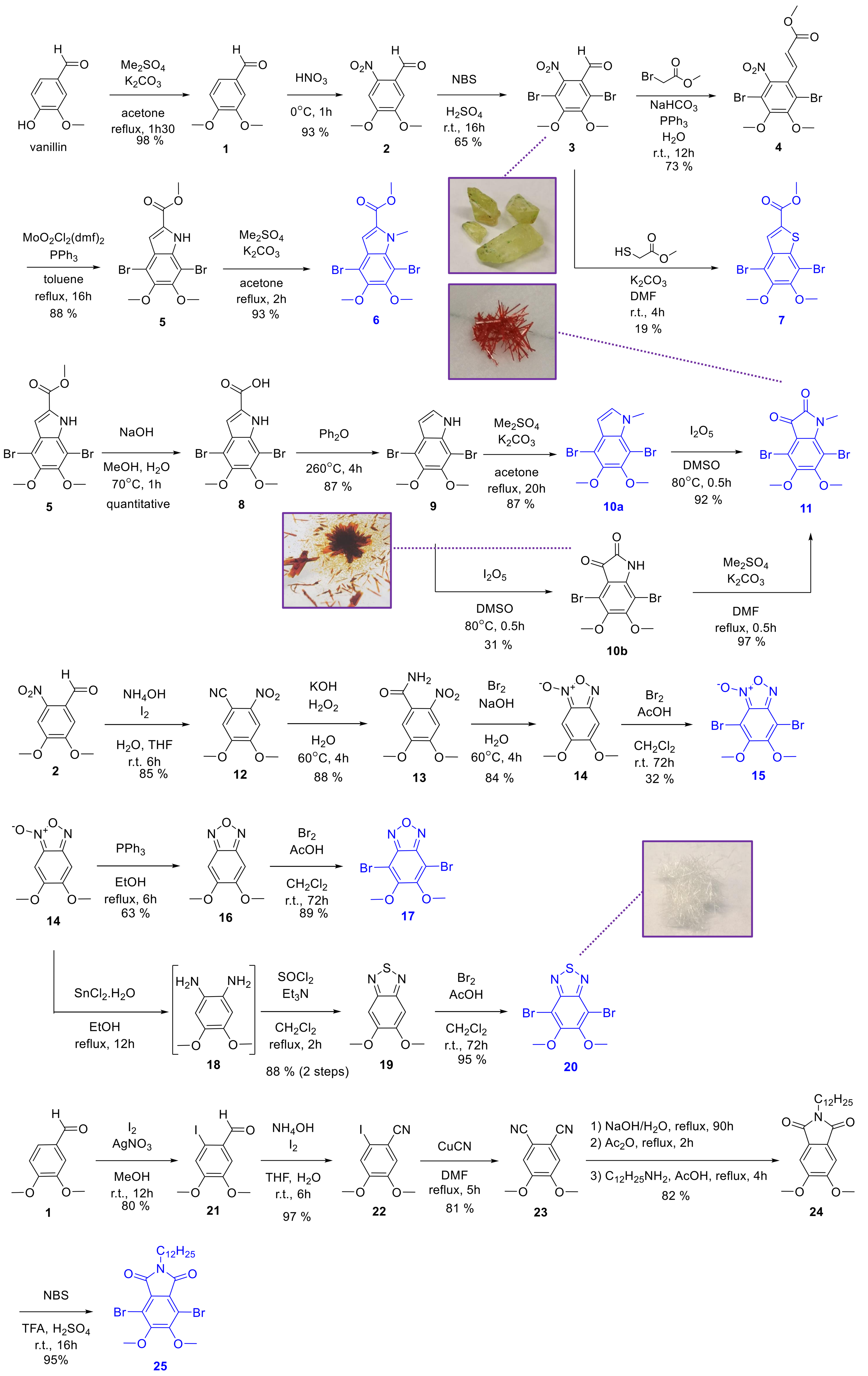
[1]Department of Chemistry, Université Laval, Québec (QC), Canada, G1V 0A6
[2]Kemitek - Cégep de Thetford, Thetford Mines, (QC) Canada, G6G 0A5

Introduction

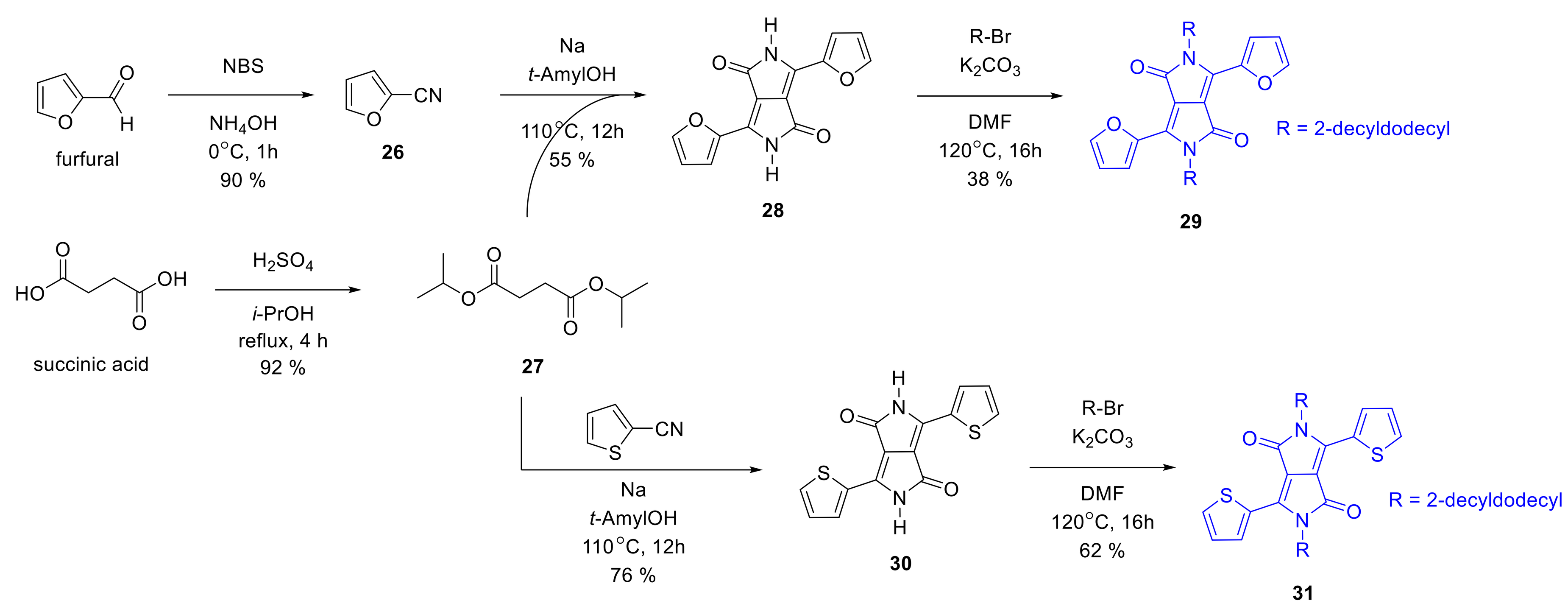
Electronic is so well integrated into our lives that it would be difficult to imagine a single day without the support of modern technology. Undeniably, these electronic products (cellphones, tablets, portable computers) have become essential tools in our daily routine. However, the fact remains that their lifespan is limited and that the resources used for their manufacture are demanding on the environment. A drastic change in the way we harness resources and manage electronic waste is required to minimize negative impacts on our environment. In order to eliminate electronic waste, materials from renewable and recyclable sources are sought. In this regard, forest biomass is considered the only sustainable source of organic carbon and therefore the ideal replacement of petroleum products to produce sustainable chemical compounds. One of the resources derived from biomass, lignocellulose, is the most abundant bio-based material on earth. Indeed, the main value-added compound obtained from the depolymerization of lignin is vanillin. Vanillin is an aromatic compound with three functional groups which can be chemically modified (methoxy, aldehyde and hydroxyl). The present work describes how the vanillin moiety can be expanded into several novel building blocks for the preparation of sustainable conjugated polymeric materials.



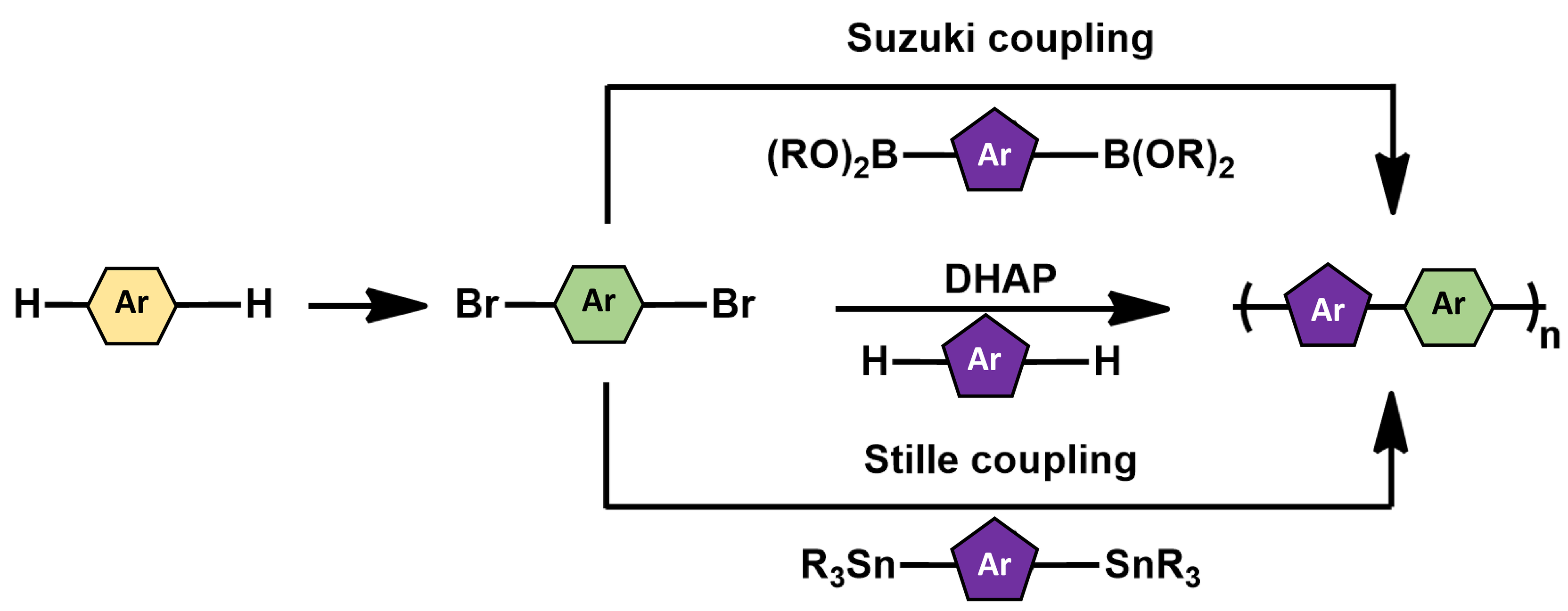
Vanillin-based monomers synthesis



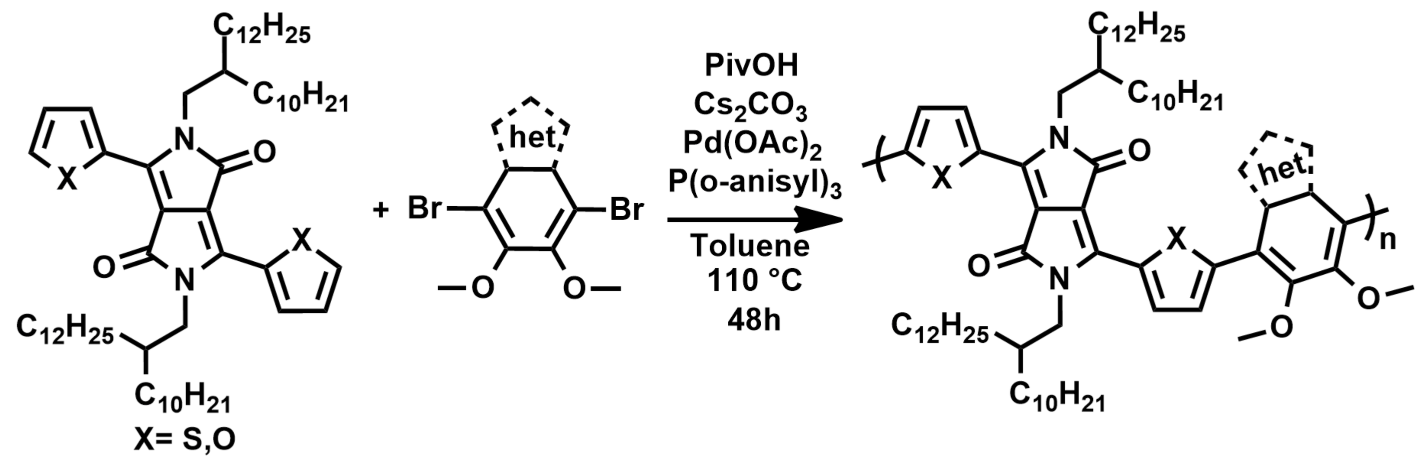
DPP furan-based monomers synthesis

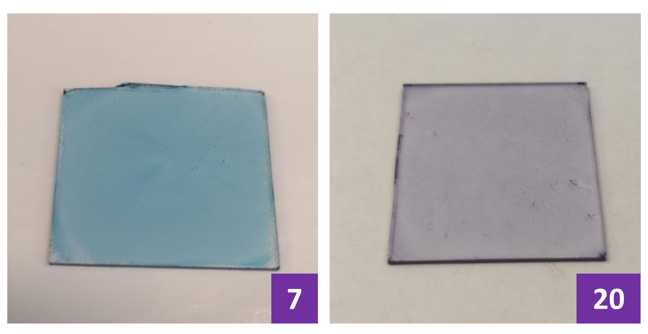


Polymerization



STILLE COUPLING	SUZUKI COUPLING	DHAP
• More synthetic steps • Highly toxic reactants • Highly toxic byproducts	• Adaptable to aqueous conditions • More synthetic steps • Unstable and/or more costly reactants	• Adaptable to aqueous conditions • Less synthetic steps • No highly toxic byproducts • Less costly reactants





Biosourced monomer	DPP*	E_g	HOMO	LUMO	M_n	M_w
		(eV)	(eV)	(eV)	(kDa)	(kDa)
7	Th	1.59	-5.29	-3.75	17	34
6	Th	1.72	-5.44	-3.68	19	45
	Fu	1.67	-5.01	-3.24	6	12
25	Th	1.62	-5.31	-3.60	10	18
	Fu	1.83	-5.12	-3.23	10	22
11	Th	-	-	-	-	-
20	Th	1.31	-5.36	-3.73	2	3
17	Th	1.36	-5.41	-3.79	1	2
15	Th	-	-	-	-	-

*Th= thiophene, Fu= furane

References

- Boivin, L.-P.; Dupont, W.; Leclerc, M.; Gendron, D. Biosourced Vanillin-Based Building Blocks for Organic Electronic Materials, *J. Org. Chem.* **2021**, *23*, 16548–16557.
- Sonar, P; Singh, S.P.; Williams, E.L.; Li, Y.; Soh, M.S., Dodabalapur, A.; Furan containing diketopyrrolopyrrolecopolymers: synthesis, characterization, organic field effect transistor performance and photovoltaic properties, *J. Mater. Chem.* **2011**, *22*, 4425-4435.

Fonds de recherche Nature et technologies Québec

CRSNG NSERC