INSTITUTE FOR MOLECULAR AND SUPRAMOLECULAR CHEMISTRY
Laboratory of Organic and Bio-organic Chemistry

PhD Project – CSC / UT-INSA 2020

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Green Chemistry: innovative routes to fine and specialty chemicals from biobased platform molecules.

绿色化学：由生物基平台分子合成精细/专用化学品的新路线的设计与开发

Abstract: Greener strategies towards greener chemicals must include more renewable carbon resources. Among renewable building blocks, 5-hydroxymethylfurfural (HMF) is considered as an important intermediate due to its rich chemistry and high availability from carbohydrates. The PhD project will aim at developing novel routes using atom-economical reactions for constructing functional molecules from biomass with applications ranging from specialty to fine chemicals. Other furanic compounds analogous to HMF, such as furfural, chloromethyl furfural or glucosyloxymethyl furfural will be considered, widening the range of synthetic methods and applicative aspects. The project will provide a strong chemical education in synthetic organic chemistry and will offer opportunities to collaborate will other groups in France and abroad specialized in catalysis, bioorganic and physical chemistry, with respect to the various applications which will be envisioned.

Important dates for candidates: contact us as soon as possible starting July 2019, deadline for applications Nov 1st, 2019, final interview January 2020, PhD start Autumn 2020.

摘要：绿色策略合成绿色化学分子应该充分利用可再生的碳资源。在各种可再生有机合成中间体中，5-羟甲基糠醛（5-羟甲基呋喃甲醛）因其丰富的化学反应性和易于从糖类中获得的特性，被认为是一种重要的有机中间体。该博士课题将利用原子经济性反应设计路线以生物质为原料合成官能化的分子，以期其具有精细/专用化学品某些方面的应用。除5-羟甲基糠醛外，诸如糠醛， 5-氯甲基糠醛，以及葡萄糖基取代的类似物也将是研究对象，以拓展合成方法及其相关应用。此课题将提供强有力的有机合成化学教育，同时根据合成分子的潜在的不同方面的用途，申请人将有机会和法国或其他国家的催化、生物有机化学或则物理化学等相关课题组合作。

重要时间点：请有兴趣申请的同学从2019年7月开始尽早与我们联系；申请截止日期为2019年11月1日；2020年1月进行最终面试； 2020年秋季入学。

Green chemistry is the way to more sustainable and safer chemical products and processes. Since chemistry intervenes in all the manufactured goods, products and materials of the everyday life and in the most important fields of our society (energy, construction, transportation, foods, hygiene, health), greener chemicals more respectful of environment will bring both economic and societal progress.

The shortage of cheap fossil resources, the necessity to integrate renewable carbon in chemicals for lowering their carbon footprint, or the search for added-value products from agricultural crops or by-products, have driven many research groups to work on finding new ways and methods for transforming biomass into useful functional molecules or valuable chemical intermediates [1-2]. In recent years, considerable efforts have been made on the transformation and uses of carbohydrates into HMF. Renewable building blocks such as HMF exhibit increasing interest thanks to their rich chemistry and availability from carbohydrates [3].

Our lab has developed strong knowledge and experience in different areas of green chemistry [4,5], in particular new methodologies in the design of carbohydrate-based functional products including in the fields of surfactants [6] and polymers [7] and novel strategies using furanic platform molecules [8]. This also includes recent collaborations with other French and Chinese laboratories [9]. This combined experience is the support of the present project which deals with the exploration of new uses of the HMF platform.

Based on our recent results on various reactions chosen for their high level of atom economy, such as Baylis-Hillman, *aza*-Baylis-Hillman], and Biginelli reactions (Figure 1) [8], the project will aim at developing these strategies to specific targets with precise properties either as specialty chemicals (surfactants, monomers…) or fine chemicals, including intermediates toward high-added value products. The project will include the exploration of other atom-economical reactions such from the hydroxymethylfurfural framework, a field of research still open for exploration. Besides HMF, the reactivity of some of its analogues, namely furfural, chloromethylfurfural (CMF) or the more elaborated glucosyloxymethylfurfural (GMF) will be also investigated, thus widening the structural range of the possible targets.

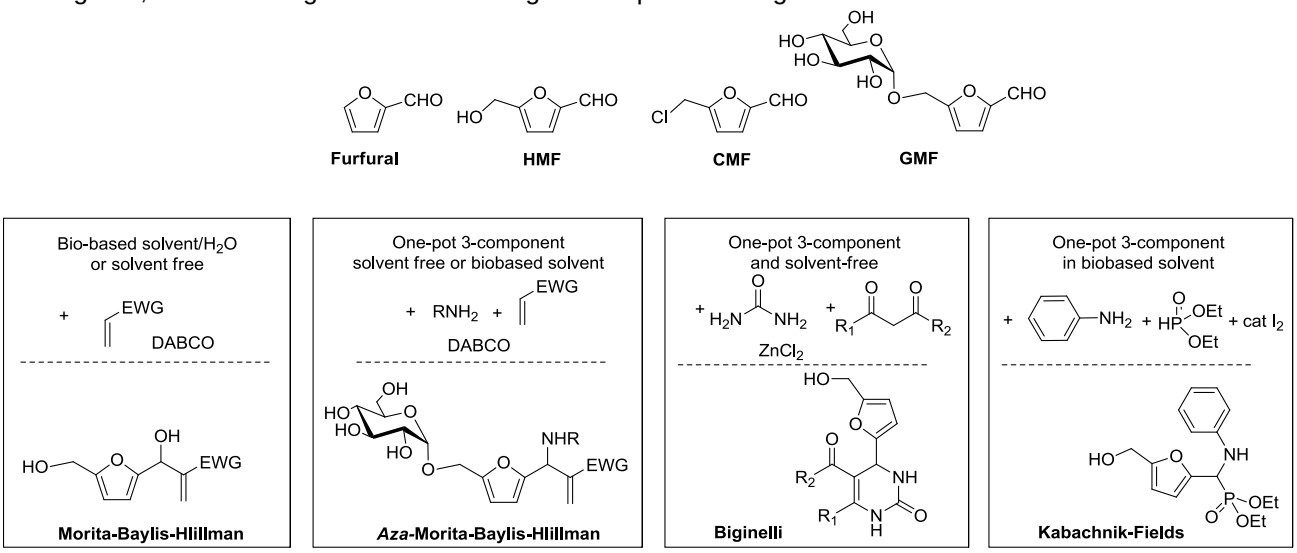

Figure 1. Recent approaches developed on the ICBMS-COB lab.

Overall, the purpose of this thesis will be to develop further the uses of carbohydrate furanic derivatives such as HMF and analogues into useful functional biobased molecules or valuable chemical intermediates, including fine chemicals.

This project will provide a strong chemical education in synthetic organic chemistry, together with a transdiciplinary experience in the frame of our collaborations will other groups in France and abroad at the interface of physical chemistry and biochemistry.

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Required background, benefit for the candidate:

The work will be conducted in Lyon, within the team "Organic and Bioorganic Chemistry" specialized in synthetic organic chemistry. The candidates must possess a strong background in synthetic organic chemistry. Experience in carbohydrate chemistry and/or in heterocyclic chemistry will be appreciated but is not mandatory. A good motivation to learn, communication skills, curiosity, and good team spirit are also among important qualities. Some knowledge of English is also important.

The work will involve various aspects of organic chemistry, notably multistep carbohydrate chemistry and multistep transformations of furanic derivatives. While focusing on synthetic organic chemistry, the project will offer opportunities to interact with colleagues in frontier disciplines such as physical chemistry, materials sciences or biochemistry and biology, depending on the possible applications of the novel biobased chemicals prepared during the thesis. The candidate will therefore benefit from a transdisciplinar education in organic chemistry and related sciences. A precise work plan will be given to the PhD candidate and careful supervision of his work will be organized, with regular work meetings and written reports.

Description of the laboratory:

The team Chimie Organique et Bioorganique is part of the Institute for Molecular and Supramolecular Chemistry and Biochemistry (ICBMS, http://www.icbms.fr/), the biggest research unit in synthetic and biological chemistry of the University of Lyon. Our team (http://www.icbms.fr/cob) is well known for its contributions in biological chemistry and carbohydrate chemistry. Early 2018, the lab has moved into its new facilities, in a brand new building with state-of-the-art facilities named "Lederer building" on the LyonTech La Doua campus. The PhD student will thus profit from excellent installations and facilities for developing his/her thesis work.

Dr Yves QUENEAU's CV:

Dr Yves Queneau (58 yo) is a **CNRS Research Director** (Equivalent to Research Professor) **and Head of the COB Team,** of the Institut de Chimie et Biochimie Moléculaires et Supramoléculaires (ICBMS), deeply involved in carbohydrate chemistry at the interface with green chemistry and with bioorganic chemistry. He graduated from the University of Paris-Sud (Orsay) in 1988, where he received his PhD under the supervision of Professor André Lubineau. Appointed as CNRS fellow in 1988, he then spent one year in Prof Samuel Danishefsky's group in New York, USA (1991). He later moved to Lyon in a mixed CNRS-industrial research facility dedicated to carbohydrate chemistry where he was promoted to a Research Director in 1995. In 2003, he joined the University of Lyon, where he has led the INSA part of the Institut de Chimie et Biochimie Moléculaires et Supramoléculaires (ICBMS) and leads the team Organic and Bioorganic Chemistry. In 2007, he was promoted to a Research Director 1st Class and since 2009, he is also appointed as **Honorary Professor at the University of Hull** (UK). He teaches carbohydrate chemistry and green chemistry in several universities in France and abroad. He was awarded the CNRS Bronze Medal in 1994 and the "Europol'Agro" Prize for Scientific Innovation in 1998 and is among the recipients of the 2010 and 2014 CNRS rewards for scientific excellence and doctoral

supervision. He develops his research in carbohydrate chemistry and bioorganic chemistry and has published more than 150 papers, book chapters and patents in his career. He serves as member in many panels and committees as well as referee for numerous journals, and is a member of the board of editors of the book series Specialist Periodical Reports of the Royal Society of Chemistry for the “Carbohydrate Chemistry, Chemical and Biological Approaches” series, and review editor for Frontiers in Chemistry, Supramolecular Chemistry. Recently, he has been invited by Prof Buxing HAN, CAS, to contribute with a chapter on “Carbohydrate-based amphiphiles : a resource for biobased surfactants” to the Volume on Green Chemistry and Chemical Engineering in the forthcoming edition of the Encyclopedia of Sustainability Science and Technology which is to be released in 2018 by Springer.

With a 35-year experience in carbohydrate chemistry, Yves Queneau is a specialist in the design, the synthesis and the study of the properties of carbohydrate containing molecular architectures, with a focus on the use of available sugars and other carbohydrate-based platform molecules as starting materials for fine chemistry with strategies directed towards new bio-based chemicals, including, surfactants and monomers.

Over the last 15 years, Dr Queneau made regular visits to China and has developed collaborations and shared the responsibility of scientific meetings successively with Prof HUANG Peiqiang (Xiamen), Prof HE Mingyuan in ECNU (Shanghai), and Prof GU Yanlong in HUST (Wuhan). He notably co-chaired the recent French-Chinese conference on Green Chemistry (www.FC2GChem.org) in Wuhan and Shanghai in Nov 2014 and in Lyon in 2016, and back in Shanghai in 2018 as a co-chair together with Prof Mingyuan HE and Prof Buxing HAN. He was guest editor in chief of special issues in Comptes-Rendus Chimie in 2008 and in Science China Chemistry in 2010 dedicated to collaborations in chemistry between China and France. He has delivered more than 50 conferences in Beijing, Shanghai, Wuhan, Guangzhou, Xiamen in the past years and also taught carbohydrate and green chemistry in Shanghai and in Wuhan. In 2015 he was awarded the LU Jiaxi lecture award by the College of Chemistry and Chemical Engineering of the University of Xiamen. He will be a member of the Scientific Committee of the forthcoming CCS Green Chemistry Conference to be held in Beijing in October 2019 on the invitation by the chair Prof Han Buxing, Chinese Acaemician.

Prof.Florence POPOWYCZ’s CV:

Prof. Florence Popowycz was born in Auxerre (France) on October 25, 1976. She graduated from the Ecole Nationale Supérieure de Chimie de Paris in 1999. The same year, she obtained a master degree of organic chemistry at the University Pierre and Marie Curie and worked in the laboratory of Prof. Jean-Pierre Genet. She received her PhD degree in 2003 from the Ecole Polytechnique Fédérale de Lausanne (Switzerland) after working on mannosidase inhibitors in the laboratory of Prof. Pierre Vogel. After a post-doctoral year in Geneva studying aminolevulinic acid derivatives and their use in photodynamic therapy, she returned to Lyon in October 2004 as an assistant professor. From September 2011, she got a full professor position at the Institut National des Sciences Appliquées in Lyon (France). Her contribution was reported in 58 publications and 6 patents. In 2010, she was awarded two prizes: the Claude Dufour award for prospective organic chemistry and the prize for encouragement in therapeutic chemistry sponsored by Servier and the therapeutic chemical society. Her main interests are devoted to the development of new synthetic methodologies by sustainable methods and its applications to new heterocyclic scaffolds.

Contacts:

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