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What can phosphorus heterocycles provide to materials science?

Abstract

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Modern organic chemistry has led to a rapid evolution of π-extended systems, since they are pivotal for the development of future technologies, particularly in organic electronics. Their beneficial properties for materials science stem from the efficient electronic delocalization across their π-extended framework. While carbon-based architectures dominate this field, the inclusion of phosphorus introduces unique properties that are inaccessible with an all-carbon framework. Notably, phosphorus stands out because of its pyramidal geometry, which may disrupt conventional π-stacking, and its special electronic characteristics; i.e. the possibility to reversibly interconvert from tri- to pentavalent form.[1] Within π-extended systems phosphorus exhibits a unique non-hybridization that originates a myriad of fascinating properties such as strong photoluminescence, electron-accepting capacity,[1] and a large variety of coordination reactions,[2] just to name a few. However, deepening into the chemistry of heteroatomic π-extended systems requires the development of not only suitable synthetic protocols capable of incorporating heteroatoms but also new strategies to control the 3D molecular arrangement, as it determines the materials' properties as a whole. Both aspects have recently attracted a great deal of research efforts;[3] the future of heteroatomic π-extended architectures will be certainly governed by the availability of straightforward means to control their overall molecular arrangement.

In this communication, I will discuss recent advancements in the multifaceted contributions of phosphorus heterocycles to the field, covering their synthesis, diverse array of properties, and potential applications. I will provide an overview of synthetic methodologies for the preparation of phosphorus heterocycles, encompassing traditional organic synthesis routes as well as cutting-edge approaches. Additionally, I will outline the unique properties of phosphorus heterocycles, including their optoelectronic characteristics and structural versatility, emphasizing their potential in materials science. Finally, I will describe emerging trends in the development of materials based on phosphorus heterocycles, highlighting applications in organic electronics, biomarkers, and bioactive drugs.

References
1. a) Hindenberg, P.; Romero-Nieto, C. Synlett 2016, 27, 2293; b) Regulska, E.; Romero-Nieto, C. Dalton Trans. 2018, 47, 10344.
2. Kollár, L.; Keglevich, G. Chem. Rev. 2010, 110, 4257.
3. Regulska, E.; Romero-Nieto, C. Mater. Today Chem. 2021, 22, 100604.

Biography

Carlos Romero-Nieto obtained his PhD in organic chemistry from the University of Castilla-La Mancha (Spain) in 2010 on the synthesis and properties of phosphole-based dendrimers. During his PhD, in 2008, he joined the group of Prof. Thomas Baumgartner, expert in the chemistry of phosphorus heterocycles, at the University of Calgary (Canada) for more than one year. In 2010, he moved to the University of Erlangen-Nuremberg (Germany), Prof. Dirk Guldi's group, to pursue a postdoc in physical chemistry on the investigation of organic/inorganic materials by ultrafast spectroscopic techniques.

In 2013, he was awarded with the Liebig Fellowship, which allowed him to start his independent career at the Institute of Organic Chemistry of the University of Heidelberg (Germany). In 2019, he obtained his habilitation to be professor in organic chemistry from the University of Heidelberg, becoming the first Spanish chemist to achieve this in the 634-year history of the university.

Back to Spain, at the Faculty of Pharmacy of the University of Castilla-La Mancha, Carlos Romero-Nieto leads a research group focused on the development of new synthetic methodologies for the preparation of novel systems based on six-membered phosphorus heterocycles for bio-applications and materials science, and the investigation of their properties. In 2016, Carlos Romero-Nieto was awarded the prestigious Hengstberger Award for Young Researchers by the University of Heidelberg. In 2018, he obtained the National Award for Young Researchers from the Spanish Royal Chemical Society (RSEQ). In 2020, he received the Award for Young Researchers from the Spanish Royal Chemical Society of Castilla-La Mancha, and in 2021, he was named a Fellow by the International Association of Advanced Materials. In 2023, Carlos was awarded the Prize for Young Researchers from the Regional Government of Castilla-La Mancha, the recognition "Yugo Quijote," and the ERC Consolidator Grant. In 2024, he received the Scientist Medal from the International Association for Advanced Materials and was honored with the distinction of Knight of the Order of Santiago for his scientific achievements.