

Venerdì, 23/07/2021

alle ore 11:30

il **Dr. Manuel Serrano Ruiz**

CNR-ICCOM

Firenze

terrà il seguente seminario:

**"Black Phosphorus: from its synthesis, exfoliation and reactivity  
towards its Functionalization"**

Il seminario sarà tenuto in modalità telematica, tramite accesso alla piattaforma  
GoToMeeting.

Si invitano tutti gli interessati a partecipare.

**Dr. Francesco Vizza**  
Direttore ICCOM

## Short Abstract:

Since the discovery of graphene and its amazing electronic and physical properties in 2004 by Geim and Novoselov, the interest on 2D materials has grown exponentially due to their exceptional properties which opened the way to the development of next-generation quantum technologies necessary for achieving a more sustainable and safe society. The importance of this material convinced in 2013 the European Community to invest 1 billion € in a sharply dedicated project, the Graphene Flagship, aimed at bringing graphene innovation out of the lab bolstering its commercial applications. Soon thereafter, it became clear that other 2D-materials could be prepared, including transition metal dichalcogenides, hexagonal boron nitride, MXenes, layered oxides and others. Among this rich family of graphene epigones, phosphorene, first prepared in 2014 by mechanical exfoliation of black phosphorus, has enormously grown in importance due to its outstanding mechanical, optical and electrical properties. Unlike graphene, which is a good conductor (zero bandgap), black Phosphorus is a semiconductor with a direct bandgap ranging from 0.3 eV to about 2 eV, depending on its thickness, and exhibits high electron/hole mobility, high on/off ratio and anisotropic in-plane properties making it a promising candidate for future electronics and optoelectronics devices, with applications in energy storage devices, chemical and biological sensors, catalysis and biomedicine. Like graphene, phosphorene is made up of only one kind of atom, with each phosphorus atom covalently bonded to other three  $sp^3$  hybridized P-neighbours. This fact leaves a lone pair of “free electrons” on each P-atom that could be chemically active, which justifies why phosphorene single layers featuring a puckered honeycomb structure, stacked together by van der Waals interactions to form bulk orthorhombic black phosphorus. The electronic and optoelectronic properties of black phosphorus and phosphorene, as well as their chemical reactivity, strongly depend from both the purity of the material and the quality of the crystal. In this respect, since the beginning of my adventure in Florence, my research activity has been focussed on the synthesis of high quality black phosphorus crystals for electronic applications and its liquid-phase exfoliation by sonication in different solvents aimed at obtaining few-layer phosphorene flakes suitable for studying its physico-chemical properties, its reactivity and eventually, for achieving its functionalization. Remarkably, the obtained material has always shown a great instability in air due to its easy reaction with oxygen and water catalysed by visible-light. In this presentation, I will show you also our preliminary results to improve phosphorene stability and how to circumvent this major drawback that largely impedes its direct application in electronic and optical devices.

## Short Biography:

Manuel Serrano-Ruiz obtained his degree in Chemistry at the National University of San Marcos, Lima, Peru (2002), discussing the thesis “Synthesis and characterization of 1,5-diphenyl-1,2,4-triazol-3-thione and bis (1,5-diphenyl-1,2,4-triazol-3-thionate) lead(II)” and his PhD in Advanced Chemistry at University of Almeria, Spain (2010), discussing the thesis “Synthesis and Chemical-Structural Characterization of Metallic Derivatives of N,N-bis[2-(diphenylphosphino)ethyl]-n-propylamine”. After a short time of six months spent in a bakelite processing industry (1994), in 1995 he started working as a laboratory assistant in the Inorganic Chemical laboratory at the Pontifical Catholic University of Peru focused its activity on problem-solving collaboration with different industries. Between 2003 and 2010 he worked in Spain attending his doctoral thesis, being involved in several scientific and industrial projects, tutoring PhD, masters and undergraduate students. From 2010 to 2014 he was the Co-advisor of three PhD Doctoral Thesis, two Master thesis and one thesis Degree in Chemistry at the University of Almeria and was involved in several scientific and industrial projects. From 2012 to 2014 he was Associate Professor in Inorganic Chemistry in the same University. From June 2014 to December 2018 he was a Post-doctoral fellow at CNR-ICCOM under the supervision of Dr. Maurizio Peruzzini where he worked in the frame of the ERC project “PHOSFUN” dedicated to explore the chemistry of phosphorene. Since December 2018 Manuel Serrano-Ruiz is a permanent researcher at CNR-ICCOM in Sesto Fiorentino (Florence), where he is currently actively working on the design, synthesis, characterization, reactivity and functionalization of 2D materials for applications in electronic devices and heterogeneous catalysis. Manuel Serrano (h-index = 18) is author of 67 scientific papers, all published in peer-reviewed journals, 6 patents, 2 book chapters and about 115 presentations at national and international conferences.