



Exploring the Pore Space of transition metal- and Ln-silicates, and MOFs

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CICECO | Aveiro Institute of Materials
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Abstract

Zeolites are porous, crystalline aluminosilicates with frameworks built from tetrahedral units connected by oxygen atoms, featuring exchangeable cations. They are used in catalysis, gas separation, and ion-exchange.

Beyond zeolites, certain microporous silicates are assembled from transition-metal and lanthanide bearing heteropolyhedra and, in addition to the conventional zeolite properties, they exhibit magnetism and light emission. This talk presents examples of applications of such materials developed in my laboratory in light emission devices and in the treatment of the medical condition hyperkalemia (excess K^+ in serum), with a new drug now on the market.

Metal-Organic Frameworks (MOFs) are hybrid materials with polyatomic metal clusters linked by covalent bonds to form nanoporous structures. In contrast with zeolitic materials, MOFs operate in milder conditions and, comparatively, often lack robustness, but they are much more amenable to 'rational synthesis' and post-synthetic modification using the conventional methods of organic synthesis. In this talk, I shall present some examples of my groups' research on MOFs, encompassing temperature sensing via light emission, anti-mosquito textile nets, and uranyl ion capture from waters.

The talk will also cover my recent group's research on photoresponsive organic-inorganic hybrid molecular ferroelectrics with potential application in memories and optical switches..

Biosketch

João Rocha is Full Professor in the Department of Chemistry at the University of Aveiro, Portugal, and was the Director of CICECO-Aveiro Institute of Materials until the end of 2021. He earned his Ph.D. from the University of Cambridge, UK, in 1991, completed a subsequent post-doc there.

Rocha is renowned for establishing a new field of materials similar to zeolites, focusing on microporous silicates of transition metals and lanthanides. He has pioneered their use across luminescence, catalysis, gas sorption and separation, ion exchange, magnetism, and as MRI contrast agents. Notably, one microporous zirconium silicate has found commercial application as a drug for hyperkalemia treatment.

Moreover, he has developed luminescent lanthanide-bearing Metal-Organic Frameworks and related organic-inorganic hybrids for use in nanothermometry and as photoresponsive ferroelectrics with high Curie temperatures. This work has opened new avenues in multi-state ferroelectric memories, optical switches, and optoelectronic devices. He has also pioneered the development of solid-state NMR techniques for studying quadrupolar nuclei.

Rocha is an elected member of the European Academy of Sciences (EURASC), the Royal Academy of Belgium, and the Lisbon Academy of Sciences, and a Fellow of the Royal Society of Chemistry and Chemistry Europe. His accolades include the Ferreira da Silva prize, the Madinabeitia-Lourenço award from the Spanish Royal Society of Chemistry, and the French-Portuguese prize from the French Chemical Society. He has published ca. 550 papers generating over 24,000 citations (Scopus h-index 72), mentored 43 post-docs and 36 Ph.D. students, coordinated over two-dozen projects, and consulted widely for industry.