Lanthanide-based logic: a promising approach in the field of molecular computing

Sofia Zanella[1], Miguel A. Hernández Rodríguez, Rute A. S. Ferreira[1], Luís D. Carlos, Carlos D.S. Brites[1]

[1]Phantom-g, Physics Department and CICECO-Aveiro Institute of Materials
[1]University of Aveiro, Aveiro 3810-193, Portugal
zanella.sofia@ua.pt

The exponential growth of information, along with the evolution of networking and the Internet of Things, is posing significant technological challenges. With Si-based integrated chips approaching their miniaturization limit, a new generation of efficient computing systems is needed. Molecular computing, which uses molecules to perform logic operations, has the potential to play a decisive role in the future of the computer industry. Molecular logic gates, like electronic devices, can be stimulated by various input signals to produce optical outputs according to a defined logical transfer function. Ln^{3+}-based materials are particularly promising for molecular logic due to their ability to respond to both chemical and physical stimuli and their unique photophysical properties that make them suitable for photonics applications.
This presentation will focus on the main contributions of Ln^{3+} -based materials in molecular logic, discussing their potential to integrate with the future molecular photonic-electronic hybrid logic computing system. Examples of molecular logic devices that use Ln^{3+} and physical stimuli, developed in the Phantom-g research group, will be presented, describing several approaches to define diverse logic functions with distinct degrees of computing complexity such as reconfiguration, reprogramming, and concatenation. The molecular logic gates described respond to a broad variety of physical inputs such as time, temperature, UV radiation, and among others making a further step in the definition of logic operations in the solid state.

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References

[1] A.P. de Silva, N.H.Q. Gunaratne, C.P. McCoy, *Nature*, 364 (1993), 42-44, doi:10.1038/364042A0
[2] A.P. de Silva and S. Uchiyama, *Nat. Nanotechnol.*, 2 (2007), 399–410, doi: 10.1038/nnano.2007.188.
[3] S. Zanella, M.A. Hernández-Rodríguez, L. Fu, L.D. Carlos, R.A.S. Ferreira, C.D.S. Brites, *Adv. Optical Mater*., 10, 2200138 (2022), doi:10.1002/adom.202200138
[4] S. Zanella, E. Trave, E. Moretti, A. Talon, M. Back, L. D. Carlos, R. A. S. Ferreira and C. D. S. Brites, *Front. Photonics*, 3 (2022), 1-11, doi:10.3389/fphot.2022.1010958
[5] S. Zanella, M.A. Hernández-Rodríguez, R.A.S. Ferreira, C.D.S. Brites, *Chem. Comm*. (2023), under revision