Forum Inżynierii Materiałowej

Materials Engineering Forum

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Atomically precise metal nanoclusters as luminescent and chiral markers for bioimaging

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Noble metal nanoclusters (NCs) are ultra-small nanoparticles exhibiting properties on the border between discrete organometallic molecules and bigger metal nanocrystals [1]. They possess exceptional optical characteristics, including tunable photoluminescence (UV-NIR), large Stokes shifts (>0.5 eV), high photostability, and significant two-photon absorption [2]. Importantly, many NCs display chirality, arising from chiral surface ligands, helical core motifs, or inherent kernel asymmetry. These attributes make NCs excellent models for structure-property relationship studies and versatile tools in catalysis, bioimaging, and sensing.
Our work investigates the linear and nonlinear optical properties of gold and silver NCs [3, 4]. We synthesized and characterized NCs with NIR emission and with chiral properties, stabilized by 1) chiral ligands within primary or secondary ligand shells (captopril, glutathione, arginine, single stranded DNA), and 2) achiral ligands where chirality was induced by the arrangement of staple motifs. We quantified their circular dichroism, as well as chiral nonlinear optical properties, specifically two-photon circular dichroism (2PCD) [5, 6]. Our findings reveal that the 2PCD of these NCs is approximately 300 times stronger than their one-photon anisotropy factor. Furthermore, we successfully demonstrated the facile detection of both 2PCD and three-photon circular dichroism (3PCD) in chiral gold NCs [7]. This research opens new avenues for application of nanoclusters in bioimaging and advanced photonic technologies.

References

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The research was carried out in collaboration with:

- Prof. T. Buergi, University of Geneva, Geneva, Switzerland
- Prof. S. Copp, UC Irvine, Irvine, CA, United States
- Prof. R. Antoine, ILM CNRS Lyon, Lyon, France