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Atomically Precise Metal Nanoclusters as Luminescent Probes for Bioapplications.

Prof. Rodolphe Antoine

Institut lumière matière, UMR5306, Université Claude Bernard Lyon1-CNRS, Univ.

Lyon 69622, Villeurbanne cedex, France.

rodolphe.antoine@univ-lyon1.fr

Ligand protected metal nanoclusters (NCs) are an emerging class of quantum materials connecting the gap between atoms and bulk metallic materials [1]. Owing to their unique electrical, optical and other spectroscopic properties such as luminescence, they are very important in various applications such as sensing and bio-imaging. Concerning optical properties, strongly emissive nanoclusters are highly desirable. Strategies such as aggregation-induced emission, metal doping and ligand-shell rigidifying for increasing the photoluminescence (PL) quantum yield and tuning the PL colors of nanoclusters have been proposed. Nonlinear optical (NLO) characteristics of such quantum clusters have revealed remarkable features [2]. The two-photon absorption (TPA) cross section of ligated noble metal nanoclusters is several orders of magnitude larger than that of commercially available dyes [3]. I will review promising applications of these fluorescent nanoclusters, with particular focus on their potential to impact to biological applications [4-7].

References

- [1]. Antoine, R., Supramolecular Gold Chemistry: From Atomically Precise Thiolate-Protected Gold Nanoclusters to Gold-Thiolate Nanostructures. *Nanomaterials* 2020, 10, 377.
- [2]. Bonačić-Koutecký, V.; Antoine, R., Enhanced two-photon absorption of ligated silver and gold nanoclusters: theoretical and experimental assessments. *Nanoscale* 2019, 11 (26), 12436-12448.
- [3]. Russier-Antoine, I.; Bertorelle, F.; Vojkovic, M.; Rayane, D.; Salmon, E.; Jonin, C.; Dugourd, P.; Antoine, R.; Brevet, P.-F., Non-linear optical properties of gold quantum clusters. The smaller the better. *Nanoscale* 2014, 6 (22), 13572-13578.
- [4]. Combes, G. F.; Fakhouri, H.; Moulin, C.; Girod, M.; Bertorelle, F.; Basu, S.; Ladouce, R.; Bakulić, M. P.; Maršić, Ž. S.; Russier-Antoine, I.; Brevet, P.-F.; Dugourd, P.; Krisko, A.; Trajković, K.; Radman, M.; Bonačić-Koutecký, V.; Antoine, R., Functionalized Au15 nanoclusters as luminescent probes for protein carbonylation detection. *Communications Chemistry* 2021, 4 (1), 69.
- [5]. Combes, G. F.; Vučković, A.-M.; Perić Bakulić, M.; Antoine, R.; Bonačić-Koutecký, V.; Trajković, K., Nanotechnology in Tumor Biomarker Detection: The Potential of Liganded Nanoclusters as Nonlinear Optical Contrast Agents for Molecular Diagnostics of Cancer. *Cancers* 2021, 13 (16), 4206.
- [6]. Yuan, H.; Theresa, M.; Bain, D.; Fakhouri, H.; Sreekanth, K.; Ravi, A.; Thomas, S.; Kalarikkal, N.; Antoine, R.; Radhakrishnan, E.K. Singlet oxygen generation efficiency and antimicrobial ability in glutathione protected Ag31 nanoclusters. *Inorg. Chem. Commun.* 2024, 159, 7, doi:10.1016/j.inoche.2023.111799.
- [7]. Cheng, Y.C.; Zhao, Y.; Yuan, H.; Zhou, H.M.; Xu, J.M.; Chen, X.H.; Zhang, K.; Antoine, R.; Zhang, S.J. Bovine serum albumin protected Cd₈ nanoclusters as efficient two-photon absorbers for near-infrared excited fluorescence imaging of intracellular pH. *Sens. Actuator B-Chem.* 2023, 394, 10, doi:10.1016/j.snb.2023.134427.