Development in nanoscience research is already reaching to the ultimate level, i.e. atomic precision. Even large molecules such as DNA and proteins are extensively studied and manipulated on single-atom scale by talented chemists and biochemist from around the world. The establishment of precise structure and property relationships in nano-scale is of great importance and will revolutionize numerous aspects of everyday life by addressing present-day challenges and scientific problems. In terms of nano-chemistry and nano-technology, colloidal gold nanoparticles are intensely investigated due to functionalities unavailable for other groups of nanomaterials. What is more, from early 2000s, number of studies on the "atomically-precise nanoclusters" (APNCs) have exponentially intensified, which underlines their contemporary significance. These unique nano-materials with precisely defined chemical composition constitute the bridge between single atoms and bulk materials. Unique properties of APNCs, governed by quantum confinement effects, provide broad spectra of functionality transgressing the possibilities available for plasmonic nanostructures or quantum dots.

The project is aimed at the design, synthesis, purification and physicochemical characterization of a novel, smart and fluorescent in near-infrared wavelengths range APNCs for applications in bioimaging (with two-photon microscopy). Our APNCs will be stabilized with supramolecular ligands: crown ethers (CEs) to enhance their functionality. Crown ethers possess an ability to selectively and non-covalently interact with cations in size corresponding to the CEs cavity (molecule ring size), which influence on affinity to water- or -organic solvent. We introduce CEs supramolecular functionality into atomically-precise nano-chemistry field to achieve control over nanocluster hydrophobicity which was never achieved before. Our preliminary studies confirmed that nanoclusters (yet not atomically-precise) functionalized with CEs have inherited ligand properties and were able to be transferred from water to the organic solvent (fig. 1). Moreover, quantitative description of nanoclusters nonlinear optical (NLO) properties will be executed to evaluate their mileage in two-photon microscopy (e.g. by z-scan or two-photon fluorescence-excitation method). Our functionalized APNCs are potent for future *in vivo* imaging with two-photon microscopy.

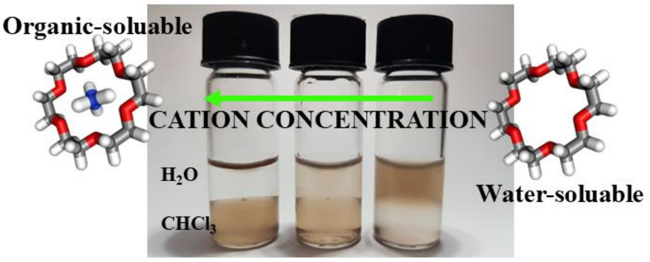

Figure 1. Crown-ether capped nanoclusters phase transfer (from water to organic phase) upon interaction with cations.

As a result of this project, several publications indexed in the Web of Science and JCR database are planned. Research in the framework of this project contribute to the understanding of nanocluster formation process in the presence of supramolecular ligands, core susceptibility to functionalization and CEs ligands structure and complexation influence on clusters NLO properties. This research is pioneering in ligand engineering design for controlled modulation of APNCs hydrophobicity and will evaluate CE capped APNCs utility in two-photon microscopy.