SUMMARY FOR THE GENERAL PUBLIC

New materials with enhanced optical nonlinearity and methods of evaluating their parameters

There are many amazing features of lasers that find applications in our everyday life. The present project utilizes the ability of lasers to generate short, intense pulses of electromagnetic radiation that interact with matter in ways that are different to the usual light-matter interactions, these high light intensity effects being called nonlinear optical (NLO) effects. One of the effects that has many practical implications is the possibility of photons to be absorbed by matter at high light intensities not one-at-a-time but two or more simultaneously. This two-photon or, in general, multiphoton absorption can be applied in various technologies, including those of telecommunication, data storage and processing, but notably, the most important applications are in biological and/or medical areas. This includes diagnostic tools like nonlinear microscopy and light-activated therapies as e.g. two-photon photodynamic therapy.

The present project, involving researchers from Poland (Wroclaw University of Science and Technology), France (Univ. Rennes 1 and École Normale Supérieure de Lyon) and Australia (Australian National University), targets the issue of finding the best high-performance materials for applications of nonlinear absorption. Our knowledge of NLO materials, accumulated over the years of working in the field, much of it in collaboration with each other, will be used to design new chemical compounds with optimized properties, to synthesize them and critically evaluate their respective merits.

Most of the synthetic work will be carried out in the laboratories in France and in Australia, with the participation of members of the Wroclaw team. On the other hand, the NLO characterization of the obtained materials will be carried out mostly in Wroclaw, employing the femtosecond laser systems available here and utilizing the experience of the members of the Wroclaw team in setting up and performing NLO measurements. We shall pay special attention to the issues of reliable determination of the properties of the materials that are relevant to the intended application, in particular, we shall determine so-called “merit factors” discussed by us in our previous papers, that allow one to compare different types of materials from the point of view of their practical suitability.

For the best molecules synthesized in our laboratories we shall also attempt the demonstration of their usefulness in proof-of-principle experiments carried out under conditions corresponding to the actual application.