Background / state-of-the-art. Superconductivity is an unusual physical phenomenon; passing of electric current through a given material (called *superconductor*) meets no resistance, hence there are no associated energy losses. This is of course highly beneficial, as one may save money or decrease the production of electric current (with concomitant decrease of environmental pollution – one of key headaches of the modern society). Thanks to superconductors we may also build fast trains (based on magnetic levitation), strong magnets needed for MRI scanning of our health, and ultra-fast new generation CPUs (as early as in 1988 a prototype of 1 GHz CPU was constructed based on superconductors!). Regretfully, materials must be cooled to low temperatures to superconduct, usually close to the absolute zero temperature (–273 ^{o}C, a real super chill!); practical use of superconductors is quite limited by this factor. Still, they have fascinated researchers for over 100 years, also due to mathematical beauty hidden in them (*zero* resistivity, *infinite* conductivity, and so called magnetic susceptibility equals precisely *minus 1* – thus we touch here the abstract concepts of zero, infinity, and negative number. Thus, it is not surprising that several Nobel Prizes were already awarded for research on superconductivity – and despite it being a rather narrow field of modern science. The key goal of current research is to raise temperature in which superconductors may reveal their unique features.

Project goals & reasons for choosing the research topic. Many types of superconductors are known, but at atmospheric pressure only one family of materials must be cooled „moderately" *i.e.* to –110 ^{o}C, to enter the superconducting state. These materials, known for over 30 years, are called oxocuprates (for they contain oxygen and copper). The theoretical work (2001) coauthored by PI of the current project, suggested a range of marked similarities between oxocuprates and fluoroargentates (*i.e.* other type of chemical compounds which contain fluorine and silver), while anticipating also the possibility of occurrence of superconductivity in the latter family. Subsequent 17-years lasting research delivered experimental proofs of all suggested similarities; it was even pointed out that fluoroargentates are better superconductor precursors than oxocuprates (thanks to stronger magnetic interactions in the former group of compounds). The last stage of research facing scientists consists of *doping*. Doping means such chemical modification of a material, that its chemical formula cannot be expressed using simple one-digit numbers (*e.g.* rock salt is NaCl *i.e.* Na_1Cl_1), but it necessitates using non-integer numbers (*e.g.* $Na_1Cl_{0.895}$). Precisely this type of modification of oxocuprates results in the appearance of superconductivity; and we aim at achieving doping to fluoroargentates in the current project. This is not trivial, though; not every chemical compound may be doped to the desirable degree. Substantial experience of the PI and collaborating scientists worldwide justifies realization of the current project with its headquarters in Warsaw.

Research to be carried out. Project is highly interdisciplinary and it will be conducted in broad international cooperation. Four world-class experts from Slovenia, Italy, USA, and Singapore, will serve as official partners of Polish scientists. Moreover, many more researchers from China, Great Britain, Switzerland, Georgia, Slovak Rep., Italy, USA, and Poland, will participate. Chemists will focus their efforts in the field they are indispensable in – *i.e.* materials synthesis. Involvement of physicists is crucial, though, as they offer in-depth understanding of properties of crystals. So called silver difluoride (AgF_2) will be the main precursor material; it will undergo numerous modifications using advanced *crystal engineering*, as well as will constitute the basis for a number of unprecedented chemical stoichiometries. We will investigate the structure of materials (*i.e.* the way atoms are arranged in the solids), the nature of chemical bonds, as well as electronic, magnetic, and other important properties. Obviously, we will search for the signatures of superconducting behaviour. Substantial support in the project will be offered by the state-of-the-art theoretical calculations using supercomputers at ICM, The University of Warsaw; the calculations and modeling will give us better understanding of the manufactured samples.

Project impact on science and society. Our ambitious goal is to generate new better superconductors, which could be used without necessity of cooling them at all – this alone constitutes an nontrivial scientific goal and every step counts which we can make towards that dream. We would like also to preserve the lead position of the Warsaw team in the research on fluoroargentates, which we gained during nearly 2 decades of hard work on many chemical systems. Several young scientists will be trained to take the lead in the future. In a more distant perspective one may think of important consequences for the country and the society. According to the US Geological Survey Poland has *the largest* documented silver ore deposits in the world – this is our „crown jewel". Sadly, most of it is turned into metal ingots (rather than high technologies and advanced materials) and sold cheaply to stock market speculators. Perhaps, based on the basic research contained in this project, new interesting applications could be found for this valuable semi-precious metal, while benefiting our society and civilization.