Thermal conductivity of ceramic materials depends on two main factors: a type of applied ceramic compound (material component) and microstructure of a final product (technological component). Considering a material component, one can state, that heat transport in a solid phase is mainly related to directed movement of phonon gas, which is responsible for conversion of energy. On the other hand, thermal resistance (insulation ability) defines size of resistance, offered by elements of material structure towards thermal waves, spreading in this material. Spreading of thermal waves, as a result of an-harmonic vibration of atoms in a crystal lattice, is a reason of thermal resistance. **Defects of crystalline structure,** which constitute a natural obstacle for spreading the thermal waves, are other reasons of thermal resistance. First of all, line defects and point defects, particularly **foreign atoms** in a crystal lattice, causing disturbance of periodical order in vibration of atoms, are included into these defects. A scale of this defect is connected with difference of masses (**mass fluctuations**), size of atoms and differences in energy of interatomic bonds (**fluctuations of deformation field**). An average value of phonons free path can also be reduced, as a result of dispersion of phonons on grain boundaries, including spots on **inter-phase borders**, however it has significant meaning in a case of materials with **sub-crystalline** structure. All these factors make a mean way of phonons be shorter, and in this way they are responsible for an effect of thermal conductivity. Applying these assumptions, creation of a new group of materials was proposed. These materials would unite various elements, thus providing reduction of the thermal conductivity (shortening of a mean free path of phonons), and related to: obtaining sub-crystalline structure, defects of crystalline structure of solid solutions and production of inter-phase boundaries. **Introduce of Al2O3** is aimed to reduce proneness to produce transitory phases, just of a production stage of ceramic material and this way to even out proneness to produce transitory phases in long lasting annealing conditions in contact with phases rich with aluminum and with aluminum oxide itself. Literature data, concerning materials type ZrO_2 - Y_2O_3 - RE_2O_3 - Al_2O_3, are very poor and they concern mainly eutectic materials type DS CMC, i. e. composites, which directionally crystallizes on a matrix of ceramic compounds of eutectic composition. There is not any information on materials from this group of different phase composition, especially data on their thermal and ion conductivity. **A scope of studies, carried out in the project**, unites knowledge from a typical area of material engineering and basic mechanisms of thermal conductivity and ion conductivity. Usage of basic knowledge from a sphere of physics is proposed, while this usage concerns influence of a defective of lattices of solid solutions on shortening the average volume free path of phonons, and this way it makes phonon waves be dispersed and thermal conductivity be lowered (with simultaneous increase in ion conductivity). Studies of thermal conductivity and ion conductivity will be carried out and they will concern the following: • introducing the lattice defects into solid solution - Zr(Hf,Ce)O2; • effect of fluctuation of mass and deformation field (introducing of rare earth elements); • generating the sub-microcrystalline structure of high density on grain borders; • generating the multi-phase structure. **Objective:** Evaluation of possibilities to get new sub-microcrystalline ceramic materials (bulk or powders) from the $ZrO_2(+CeO_2,HfO_2)$ - Y_2O_3 - $RE_2O_3(+Al_2O_3)$ system with significantly improved thermal and electrical properties and characterization of these properties, are scientific purposes of this project. These materials should exhibit lower thermal lattice conductivity, in relation to other material, i. e. ZrO_2 zirconium oxide, modified with Y_2O_3 (8YSZ, which at present is the most effective material of high-temperature insulation properties). An effect of decrease in thermal conductivity will be got by formation of the new type of the solid solution of tetragonal ZrO_2 oxide with the additive in a form of other oxides type HfO_2 and CeO_2 of similar type of a crystal lattice and oxides of rare earth elements type RE_2O_3. Equilibrium multi-phase materials with an Al_2O_3 additive, constitute the second group of worked out ceramic materials since alumina is not expected to form compounds nor the solid solution in the tested system. In this case, generation of equilibrium inter-phase boundaries will be an additional factor influencing on lowering the thermal conductivity. In all cases, initial materials of sub-crystalline structure will be used to produce final powder or bulk materials, what should provide additional reduction of thermal conductivity, as a result of generation of a great number of grain boundaries. Working out the material characteristics, comprising some selected thermal and electrical properties of new ceramic materials, will be **an effect of studies**, carried out in the project. Moreover, these studies will enable to evaluate sub-microcrystalline structure, additives of oxides of different types and phase composition to lower thermal conductivity and electrical properties of new insulation ceramic materials, what will constitute area of basic studies. Evaluation of stability in phase composition and thermal – chemical compatibility of these materials will be performed as well, what will decide on their durability. **The results** should significantly expand of knowledge about the possibilities of production and properties of new single-and multi-phase insulation materials with maintaining the sub – microcrystalline structure of the starting materials. It is essential that the combination of experimental methods and numerical simulations which will be characterized the insulating capacity of the material received, will allow for the planning of experiments in order to provide as much information from a cognitive point of view.