The scientific purpose is to clarify mechanisms associated with the formation of highly porous metallic structures by liquid-assisted processing of gas saturated melts followed by post-processing treatment. The goal will be reached by using a concept of controlling the materials structure and corresponding properties through a selection of porous-forming medium and by playing with temperature and pressure conditions during different steps of materials processing, including saturation of metallic melt with gas under high pressure, solidification of gas saturated melts under reduced pressure and post-processing treatment of solidified ingots (*thermal&pressure management concept)*.

The authors will theoretically identify and give a proper hierarchy to all factors affecting the formation of highly porous structures (including the oriented ones). Moreover, a mathematical description of nucleation and growth of gaseous bubbles in a liquid metal depending on a type of applied medium, thermodynamical conditions and thermophysical properties of involved liquid/gas/solid materials, will be given. Finally, a computer modelling of each stage of the process will be also carried out and the relationships between materials' structure and properties will be experimentally evaluated.

The newly established knowledge will be utilized in designing and fabrication of materials characterized by unprecedented performance properties. In this regard, a concept of *thermal&pressure management* will be applied for two groups of materials, i.e. pure magnesium and magnesium-based Mg-Ca alloys for those it is expected to obtain high porosity materials with significantly reduced density without losing their performance properties. A comparative investigation of such materials will give the opportunity to better recognize the mechanism (or mechanisms) playing the key role in constitution of highly porous structures upon the solidification of gas saturated metallic melts as well as the effect of porosity and second phase precipitates on the mechanical behaviour of metallic materials with ordered porosity.

The proposed topic has also a character consistent with polish positivism literature, especially with the idea described in "The Doll" by Bolesław Prus. In this novel, one of characters – Professor Geist – has developed an ultra-lightweight metal that was lighter than air and "*stronger than steel*". By following the way of Professor Geist, the authors will utilize the current progress in computer science to design and fabricate the materials that will be characterized by a lower density than that of water, and properties at least not worse than that of bulk materials. Finally, the successful accomplishment of all works will give new structural materials having performance properties that has not been yet observed in materials science.

Among others the results obtained will be a start point for the development of new generation hydrogen storage materials as well as biodegradable nature-inspired materials for orthopedic implants those structure mimics that of a bone having graded and ordered porosity.