„*The hotter the engine, the better*”. This is a title of the paper by Prof. Perepezko (University of Wisconsin-Madison) published in Nature magazine in 2009. Ten years have passed since then, and nothing has really changed. A general trend in increasing operational temperatures of energy production related devices (especially land and aircraft gas turbines) is kept and will be surely maintained in future. This is due to a simply positive correlation between temperature and efficiency of gas turbine engines. In practice, a higher efficiency means a longer flight distance under a lower fuel consumption and air pollution. Thus, one can also say “*the hotter the engine, the more environmental friendly*”. Therefore, in the view of global problems with both limited availability of fossil fuels and environmental degradation, nowadays the energy devices ought to be as “hot” as they can.

In recent decades a big step has been made in developing new generations of nickel based superalloys allowed a steady increase in engine operating temperatures. Nevertheless, it seems that at this moment, these materials have reached their maximum capabilities that are limited to T_{max} ~1150°C by their melting points and low high temperature mechanical strength. Since over 50% increase of the output power can be obtained if the operational temperature of 1300°C would be achieved, a development of novel high temperature materials is worth every single effort.

An implementation of new materials that would be able to operate *beyond superalloys* regime requires using novel materials technology design approaches. In this regard, a special attention is given to the concept of multicomponent alloys produced by mixing refractory metals (such as Mo, Nb, Ta and W) in near equal fractions. Such kind of materials having melting points above 2000°C are referred to as Refractory High Entropy Alloys (RHEA) or Refractory Complex Concentrated Alloys (RCCA), depending on a chemistry/structure complexity, and in many cases they exhibit mechanical properties at very high level (completely unattainable for the superalloys) even at temperatures as high as 1600°C. However, the main drawbacks hindering a successful substitution of superalloys by new RHEAs are mostly related with: (I) a rather poor oxidation resistance on refractory metals at intermediate temperatures (below 900°C) and (II) a much higher density (~13-14 vs. 8-9 g/cm^3) as compared to nickel based alloys.

In our Project we propose to overcome the aforementioned limitations by introducing a novel class of lightweight ultra-high temperature materials that combine the concept of RCCA with high strength oxidation resistant intermetallics containing silicon (silicides), boron (borides) and/or silicon-boron (borosilicides). Accordingly, we propose to call them *boron enhanced complex concentrated silicides (BECCS)*. We expect that these new materials will exhibit the following advantages over nickel superalloys and “conventional” refractory alloys: (i) a relatively low density (6-7 g/cm^3); (ii) an improved oxidation resistance (up to 1600°C) due to formation of continuous borosilica glass surface layer; (iii) a superior structural thermal stability ensured by a high configurational entropy of involved phases and (iv) an enhanced high temperature strength due to in-situ reinforcement by superhard high entropy borides and borosilicides.

Additionally, our engineering goal is to develop a new fabrication method of the BECCSs that would allow their processing under temperature/pressure conditions lower than that proposed in the literature for similar materials, as well as without using any toxic chemical substances as activators.

In order to achieve the Project goal a research team composed of Łukasiewicz Research Network – Krakow Institute of Technology and Military University of Technology, will be established. The Project consortium will explore a two-step approach to a fabrication of BECCSs composed of solid state and liquid state processing. The selection of process variables will be guided by a proper *in-situ* evaluation of solid/liquid state thermophysical properties of Si-B-(Al) alloys. All Project partners will contribute to a characterization of structure and performance properties of produced materials by sharing various measurement techniques available in their laboratories. Consequently, a process/structure/properties relationship for BECCSs will be obtained and practical recommendations for an upscaled fabrication will be provided.

Finally, we believe that the BECCSs produced in accordance to the proposed technological attempt can be potentially useful also for almost all high temperature applications (at T>1200°C) both as coatings or self-standing components e.g. in furnaces hardware (heaters, trays), testing apparatuses (holders, shields, tables) or in high temperature microelectronics.