The aim of the project is to investigate impact of strain rate on thermomechanical behaviour of new multifunctional titanium alloy - Gum Metal in wide spectrum of the strain rates. To this end, comprehensive experimental investigation and modeling of the influence of strain rate on the elastic-plastic transition, plastic deformation and damage of innovative titanium alloy Gum Metal subjected to compression in the range of quasi-static ($10^{-5}s^{-1}$ - $10^{0}s^{-1}$) and dynamic ($10^{1}s^{-1}$ - $10^{4}s^{-1}$) loading will be performed. The use of various techniques, including modern field optical methods, will allow obtaining experimental data with high accuracy. From the previously conducted tensile tests in the strain rate range from $10^{-5}s^{-1}$ to $10^{-1}s^{-1}$ it appears that the Gum Metal is very sensitive to the strain rate. Both the value of the maximum load reached as well as the range of reversible deformation increases, while the nature of the process evolves with increasing strain rate.

Experimental research and modeling of macroscopic polycrystalline samples of Gum Metal in a wide range of quasistatic and dynamic compression rates carried out within the framework of the proposed project, referred to the tensile test results, obtained in the scope of the previously implemented project, should contribute to explaining the deformation mechanisms of this innovative titanium alloy and its future applications.

A scheme of the experimental methodology for Gum Metal under compression including field measurement technique is shown in Figure 1. Preliminary results obtained for Gum Metal under compression using field optical measurements DIC look very promising in the context of future investigations described within this project.

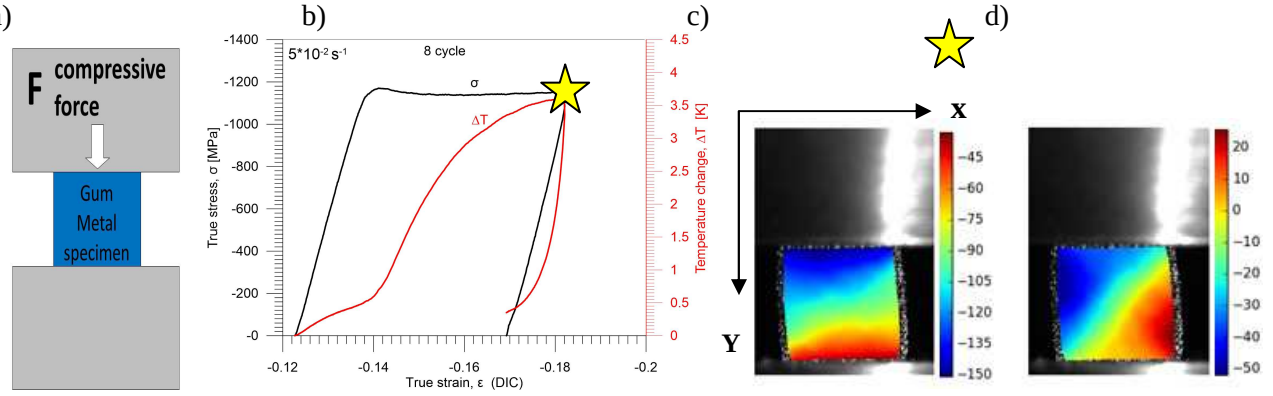

Fig. 1. Compression of Gum Metal: a) scheme of the process, b) selected curve of stress σ and temperature change ΔT vs. strain ε for during loading-unloading.
DIC displacement fields in the end of loading c) in loading direction, d) in perpendicular direction

The project has an interdisciplinary character and its implementation requires a cooperation of specialists in various fields: mechanics of materials, material science, thermodynamics, infrared research methodologies and modeling. Non-destructive ultrasonic tests will be carried out aimed at determining the Young's modulus with high accuracy, as well as a wide program of structural tests of Gum Metal samples on a transmission and scanning microscope and X-ray examinations; in the initial material state and after a certain history of loading. The project will determine the effects of thermomechanical couplings of Gum Metal in the compression process with various strain rates, also in subsequent loading cycles. In terms of quasistatic strain rates the tests will be performed on Instron testing machine, and for dynamic strain rates in the Hopkinson pressure bar system. The dependence of the load on deformation and the temperature change on the deformation and time will be determined. The Gum Metal sample ddeformation obtained from the testing machine or extensometer will be compared with the field distributions data obtained by digital image correlation DIC, the temperature will be determined with an infrared camera, and ThermoCorr software developed in the IPPT PAN will be used for their synchronization. A constitutive model for the compression process of Gum Metal will be developed and its parameters verified using the obtained experimental results.

Carrying out the research will contribute to developing international cooperation, e.g. with the research centers in Japan, France and Romania; national, e.g. with the University of Silesia and the Warsaw University of Technology, will influence the integration of teams, in particular young staff; The obtained results will be published in journals from the JCR list and presented at the national and international conferences. The implementation of the project will ensure not only the possibility of comprehensive testing of the Gum Metal unavailable on the market in the IPPT PAN in Poland, but will enable the presentation of its unconventional properties at seminars, lectures for PhD students, Science Festivals and Science Picnics - the largest event for promotion of science in Europe, organized by the Polish Radio and Copernicus Center on the National Stadium, Warsaw.