The aim of this project is to recognize and describe the mechanisms of the transformations taking place in the process of annealing of multi-layer plated coating systems formed on the basis of light metals, as well as the effect of these transformations on the formation and propagation of adiabatic shear bands (ASB) in the process of plated coating high-energy puncture.

In the performed research, it was assumed that, by way of the formation of new phases of high hardness, it is possible to stimulate a strong change in the mechanical properties of a multi-layer system. To that end, the multi-layer systems, produced with the use of the explosion welding technology, bonding under high pressure and accumulative roll bonding, will undergo long-term annealing for the initiation of element diffusion into the neighbouring layers. The composite materials based on the alloys of: Al, Ti and Mg, produced in this way will be separated by very hard layers of phases (including intermetallic) formed under the effect of a long-term operation of temperature. Such temperature/time combinations will be prepared which, in the annealing process, provoke a 'relatively fast' formation of hard phases of a 'possibly high thickness', and where the length of the applied layer will favor obtaining optimal properties of the product.

This project proposes the use of the phenomenon of element diffusion into the neighbouring layers for the 'construction' of multi-layer systems of an elevated 'breakdown resistance'. **Despite the fact that the issues investigated in the project are inspired by the actual problems resulting from industrial practice, they are strictly basic in character.** In the first part, the performed research will aim at *obtaining fundamental information on the structural and phase transformation as well as changes in the chemical composition under the conditions of 'dynamic and static thermal loads'.* They will be based on high-resolution transmission and scanning electron microscopy. The changes in the structure and the chemical composition will be analyzed both during the isothermal annealing of bulk samples and in the '*in situ*' annealing experiments. The transformations observed during the explosive welding process are very 'dynamic' and constitute a 'terra incognita' for many systems. As opposed to these changes, **the processes taking place during annealing are close to 'stationary conditions' and they are determined by the element diffusion into the neighbouring layers.** In the second part, the phenomena accompanying the process of punch (beater) penetration through the laminar structure will be analyzed. They will especially aim at describing the mechanism of the formation of plastic flow instabilities, with a special attention to the (micro)structural and crystallographic determinants of the formation of ASB during the 'impact destruction' of the plated coating. In the analysis of the observed phenomena, the application of the local orientation measuring system in scanning electron microscopy is especially useful, as it allows not only for the imaging of the (micro)structure of the joint area, but also for a simultaneous analysis of the changes in the chemical/phase composition. A complement to the realized research program will be **a numerical analysis** of the plated coatings' behaviour during the formation process as well as an analysis of the material's resistance to high-energy impact puncture, especially in the range of very high impact velocities (energies).

In the proposed series of research, the key issue is the relation between the observed state of the structure and the mechanical properties. And so, this is a classic issue from the area of materials engineering concerning research which is basic and cognitive in character. Its solution, or even solution approximation, should significantly improve the knowledge of the phase transformations taking place under dynamic conditions (high pressure and rapid temperature changes), as well as nearly stationary conditions, and also explain the mechanism of the formation and propagation of ABS in laminar structures. From the practical point of view, the performed investigations will constitute the basis for further research aiming at elaborating the technological bases of producing multi-layer materials of a strongly elevated breakdown resistance. Especially interesting are the analyses of a system based on Ti and Al. From among the many possible intermetallic phases formed with the participation of Ti and Al, especially intriguing is the possibility of the occurrence of the Al_3Ti phase, characterizing in a set of unique mechanical properties. The latter are extremely interesting for the applications in the aircraft industry (due to the very advantageous strength-weight ratio) as well as the armaments industry. In the case of the latter, composite materials reinforced with this phase are especially suggested for potential industrial applications as materials exhibiting a high breakdown resistance. They can be used not only for the protection against ballistic operations but also the ones originating from other impact hazards, both to people and vehicles or buildings.