The goal of the research project is to investigate physiochemical interaction of low-temperature plasma, generated by way of cathode sputtering with the participation of magnetic field energy, with inhomogeneous mixture of powder particles. Using plasma surface engineering techniques, the team undertakes to specify the impact of plasma particles on effective powder material condensation. We suppose, that energy stored within low-temperature non-equilibrium plasma forms **in situ surface-densed material with no need of any external mechanical force for a substance being initially powder mixture.** The innovative and not presented in literature yet technique offered in the project consists in **powder surface consolidation** based on exchange of energy between electrically excited plasma-particles and free surface of solid powder. This "transfer of energy" from plasma source (source of electromagnetic energy) to the powder surface exposed to plasma is strictly correlated with two independent energy dissipation mechanisms. The first mechanism assumes interaction of plasma components with powder particles by way of **proceeding momentum exchange** during non-elastic intermolecular collisions and afterwards sputtering of powder particles through breaking atomic bonds. The second and equally important plasma energy dissipation mechanism constitute **phonon frequencies** spreading in crystal lattice of material exposed to plasma activity (simultaneously) causing its heating. In the mentioned mechanisms crucial is impact of kinetic and potential energy of plasma gas molecules as substitute of heat energy being a stimulus during the initial surface consolidation process. The basic argument for the research hypothesis is use of dynamic stimulus of plasma-chemical reaction delivered by highly-ionized plasma gas molecules in low pressure conditions as **unconventional surface sintering and material coatings synthesis tool**. It is worth mentioning, that use of powder mixture methodology at the stage of preliminary chemical composition preparation enables to create a material with potentially any chemical composition. The proposed manner of research was not presented in literature yet, therefore it possesses high scientific potential. The project leader intends to undertake synthesis of high melting point materials (tungsten compounds), which cannot be obtained through conventional methods due to thermodynamic reasons.

The surface consolidation of tungsten powder performed during the project will serve as starting point for super hard material synthesis, which undoubtedly is tungsten nitride. From the perspective of structural and chemical composition the most desirable seems to be receipt of dense and nanocrystalline form of W_2N characterized by outstanding mechanical properties. From the utilitarian point of view, the mechanical and optical properties of tungsten nitride (W_2N) i.e. high hardness (>40GPa), excellent adhesion to the substrate, high melting temperature and satisfactory transmitation of infrared light shall prove high quality of films obtained via pulsed magnetron sputtering process. According to the project leader it is inevitable to create an electric discharge of strongly ionized plasma as energetic stimulus being a foundation of synthesis process, because forming of thermodynamically stable phase W_2N requires to overcome nucleation barrier of 72 kJ/mol.

In order to verify research hypothesis, it is planned to conduct experiments using magnetron plasma. During the research analysis the structure of surface sintered powder mixture (SEM, XRD) will be examined. What is more, the surface condensed material target will be observed in terms of thermal diffusivity, in order to specify the impact of ionized plasma environment on mass transfer mechanism on the surface of model material (Laser Flash Analysis). Necessary is also description of physicochemical state of plasma using Langmuire probe and optical emission spectroscopy (OES). The next step will be identification of synthetized condensate - the kinetics of growth, the structural – phase morphology of films deposited through sputtering and/or evaporation of atoms from the surface pre-condensed target. For this purpose, the Raman spectroscopy, spectroscopic Ellipsometry, electron microscopy SEM/TEM and diffraction method XRD are planned.