Plasma is a special synthesis environment of materials. Its use in surface engineering can lead to significant improvement of the coating material morphology towards columnar structure fragmentation, reduction of porosity and increase of coatings adhesion even at lower substrate temperatures. Research activities in this direction determine the progress paths in plasma surface engineering. The one of example is the High Power Impulse Magnetron Sputtering (HIPIMS) process introduced recently to the literature. Plasma can also be a synthesis environment that significantly influences the phase composition of the coating material, leading to the production of coatings in a phase-metastable state. In particular, plasma may be able to synthesize carbon coatings with diamond features. Influence of plasma on the formation of excited sp^3 bonds is, however, strictly conditioned by the necessity of both a very high degree of plasma ionization and its thermodynamic non-equilibrium, which can be available to achieve only for specific cases of impulse arc plasma.

The aim of the project is to show by the research that the production of such a plasma as mentioned above is also possible under glow discharge conditions during magnetron sputtering (MS).

The useful advantage of magnetron sputtering differing it from other plasma surface engineering methods is the relative ease of scaling results from the laboratory scale to the industrial scale, higher than with other PVD methods. Unfortunately, the serious disadvantage of glow discharge plasma during the dc-MS is its low degree of ionization, making this technique practically unusable for the production of DLC coatings, which is characterized by a high content of sp^3 bonds (<< 20%). It was expected that plasma which properties meeting the fundamental requirements assumed to be needed for the production of high quality DLC coatings by MS would be achievable in high power magnetron sputtering i.e. by the HIPIMS process. However, experiments described in the literature have shown that it is difficult to effectively ionize of sputtered carbon vapours even with the use of the HIPIMS. This leads to the production of DLC with a lower sp^3 bonds content (~ 50%) than it was initially expected (but with the higher content of excited carbon bonds as compare to the standard dc-MS). It seems that the favourable energy structure of the high power plasma during the magnetron sputtering can be obtained by impulse dosing of the working gas leading to the pressure oscillation in the range of its critical values (fast valve: ON/OFF). This mode of MS elaborated by the Project leader and his team has been called as GIMS, Gas Injection Magnetron Sputtering. For this way of impulse plasma generation, the time integrated pressure value is very low, the main free path is prolongated which results in limitation of plasma energy losses on collisions with working gas particles. The beneficial features Therefore such a plasma is more energetic than in the case of plasma induced by continuous gas dosing. The GIMS has been now intensively studied, but despite of that its beneficial features was proved in the form of industrial implementation. The first experiments on GIMS showed that always when the GIMS were used the rutile phase of TiO_2 coatings were deposited. The idea of the announced proposal is to research how efficient will be the joint action of the HIPIMS and GIMS (the synergy of high power and limitation of energy losses) for deposition of the DLC with sp^3 content as high as possible (of about of 70%). Additionally, the hot target effect is planned to be used for increasing the carbon sputtering yield and carbon plasma activity during the DLC coatings deposition. The hot target effect seems to be the only real solution for increasing the coatings growth kinetics, especially in the context of the HIPIMS.

One should take into account that the proposal assumptions are reflect the new, original point of view being not commonly perceived in the literature at the moment. The project realization will also lead to the creation of an novel, innovative technology on a laboratory scale, based on the original scientific concept.