Popular science abstract

The aim of the submitted project is to determine the possibility of using the self-healing mechanism in thermal barrier coatings (TBCs), exposed to significant thermophysical loads, e.g. thermal shocks. Thermal barrier coatings are multilayer coating systems. Therefore, both the metallic interlayer, the insulating ceramic top coat and the interface between them are exposed to high stresses under conditions of high temperature gradients. Over time, these stresses cause cracks to form in the ceramic top coat, which fuse together over time and eventually damage the entire thermal barrier coating system.

Research in the field of thermal barrier coatings is focused primarily on the possibility of extending their lifetime while increasing the operating temperature at the same time. For this purpose, two major concepts are developed: (I) material modifications (searching for new materials with enhanced functional properties) and (II) process modifications (considering the development of new processes or adaptation of existing technologies in order to obtain coatings with a specific structure). However, recent research is still dominated by the idea of delaying the very moment of crack initialization, which in the short time period result in the delamination and disintegration of the entire TBC system.

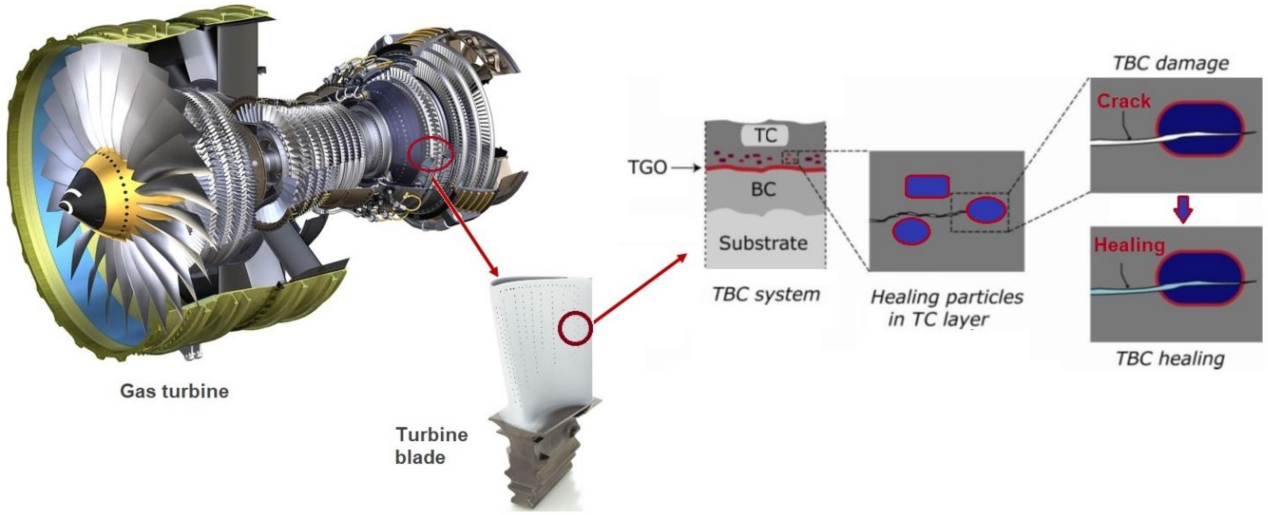

Fig. 1 The possibility of using the autonomous self-healing mechanism in thermal barrier coatings

The novelty introduced within this project is to determine the possibility of developing thermal barrier coatings using the so-called autonomic self-healing. Self-healing materials are inspired by biological systems and have the ability to repair physical damage or restore functional performance. This process can take place autonomously, i.e. without additional interference with the system. For this purpose, appropriate carbides (SiC, TiC type) will be added to the ceramic top coat of the thermal barrier. It is expected that they can be effective active agents to effectively fill cracks in the structure of the TBC system under high-temperature conditions due to the phenomenon of oxidation and volume expansion. Yttrium aluminum garnet (YAG) is one of the modern materials that can work at very high temperatures and will be used as the top coat layer in the thermal barrier coating system. YAG coatings will be prepared using various thermal spraying processes, including spraying suspensions and solutions. Based on recent research, it is expected that the preparation of this type of coating will enable controlled activation of the agent responsible for filling the crack propagated in the coating structure and the possibility of prominently extending the thermal barrier coating lifetime. However, it is crucial to explain the mechanisms of the self-healing mechanism in the TBC system and the most favorable process conditions that will ensure the expected extension of the lifetime of new generation of the thermal barrier coatings.

The idea behind the project is to study and control the self-healing mechanism of the TBC system at the microstructure level so as to extend the durability and lifetime of the coating system on a macro scale.