

The aim of the project is to perform analyses of thermal degradation processes in additive manufactured (AM) polymers without/ with carbon fibre reinforcement. AM is a common name for a group of techniques that allow to produce 3D objects in a layer-by-layer process. The main advantage of AM is possibility of manufacturing “ready-to-use” elements with complex shape, so the technique has been adopted for rapid prototyping allows to tests new design concepts. Elements manufactured using AM are applied in many industrial branches. AM polymers are widely applied due to their low weight and manufacturability with complex designs. Introducing reinforcement in a form of long carbon fibre results in material strength increasing while maintaining low weight resulting in high stiffness to weight ratio. It results in wide applicability of fibre reinforced polymers in many industrial branches, like automotive or aerospace.

The project will be realised in international cooperation between Polish (Institute of Fluid Flow Machinery, Polish Academy of Sciences, IMP PAN) and Lithuanian (Kaunas University of Technology, KTU) partners. Samples in the project will be manufactured by project partners using methods developed by them. Pure polymer samples will be manufactured by IMP PAN, while those with carbon reinforcement by KTU. Analyses will be concerned on samples with different alignment of consecutive layers and fibre reinforcement as well as thermal loading with different parameters (magnitude (negative, elevated), time (continuous, pulse, cycle), and localisation (local, global)). The thermal loading influence on AM will concern on structural and mechanical parameters changes. The structural changes will be analysed using non-destructive testing (NDT) methods, like infrared thermography (IRT), THz spectroscopy and microscopic testing. The mechanical parameters changes will be analysed based on the static tensile test that is a fundamental test in mechanical engineering. Thermal loading influences on mechanical characteristics of intact/ damaged AM samples will be modelled using finite element method (FEM). The method will be also applied for analyses of temperature distribution related to thermal loading characteristics as well as thermal waves propagation in the structure related to IRT method.

Thermal degradation processes of AM materials as well as damage sensitivity of those materials are not well known and not completely studied. Even in areas where such processes are quite good described for traditionally manufactured materials. Therefore, the justification for tackling specific scientific problems by the proposed project is to describe/ understand phenomena related to thermal degradation processes of AM materials and making an attempt to predict thermal damage evolution. Nowadays, AM techniques are widely developed and have many every day use and industrial applications. Understanding degradation processes will lead to increase structural reliability and safety level of constructions where traditionally manufactured materials are going to be replaced by AM. Thermal loading can results in a damage (e.g. delamination, crack) occurrence in AM element that decreases element strength increasing the possibility of an accident.

The project results will concern on gaining knowledge about thermal degradation processes of AM materials. One of the important issue will be complex analyse of thermal loading influence on AM material mechanical and structural characteristics. The project results will be numerical models and experimental investigation results related to thermal degradation processes. They will allow making an attempt to predict thermal damage evolution process under known thermal loading parameters and having information about AM process and material parameters.