Most of numerical simulations of elasto-plastic material deformation conditions are carried out by means of the finite element (FE) method, which can be successfully used in modeling of standard plastometric tests (e.g. compression, tension, torsion) as well as complicated metalforming operations (e.g. closed die forging, porthole extrusion, shape rolling). However, the accuracy of a finite element solution, among finite element mesh density or initial and boundary condition definitions, is particularly related to proper description of material hardening behavior.

Plastometric tests at different deformation conditions are often used to provide information on material response during loading. To improve mathematical description of obtained results, interpretation of these data can be efficiently carried by means of the inverse analysis technique. That way influence of heterogeneities related e.g. to friction or deformation heating, can be taken into account and eliminated from the solution. Eventually, set of homogenized flow stress data in the investigated range of process conditions is provided. These data are then usually described by a single flow stress equation representing behavior of the entire material, implicitly including influence of local morphological heterogeneities such as different phases, inclusions, precipitations etc., during FE analysis. With this assumption, it is often possible to simplify 3D geometry of the investigated components into the 2D space e.g. uniaxial or plain strain deformation conditions. Such reduction in computational domain order (model order reduction MOR) significantly reduces model execution time, what is crucial for practical application of these numerical approaches in the industry. However, it is important that the reduced-order model preserves certain crucial properties of the original process or phenomenon. Advantages provided by the approach are widely appreciated and used in scientific as well as practical industrial investigations of large scale metalforming processes.

However, it seems that since the beginning of new millennium the approach not always provide satisfactory description of material behavior. This is mainly related to two issues that the industry is presently facing:

- fast development of modern metallic materials like complex multi-phase steels, aluminium, magnesium or copper alloys, which are characterized by elevated material properties that are directly related to sophisticated microstructures. Interactions between different phases, inclusions or precipitations directly influence microstructure response to processing and exploitation conditions and should not be described by a single homogenized flow stress model.
- development of micro forming technologies, where sample is no longer an aggregate of billions of microstructural features but contains significantly limited number e.g. hundreds of them. Like in the previous case, interactions between particular features cannot be neglected and described by a single flow stress model.

**Thus, presented conventional numerical approaches referred in the literature as mean field models, do not meet requirements of modern material science, which is trying to develop new materials based on close relations between sophisticated microstructure morphologies and elevated in-use properties.**

**That is the reason why, it is so important to develop numerical models that can take into account the underlying microstructure morphology and its evolution in an explicit manner. This class of models is called full field approaches.**

To address presented issues, different solutions capable of detailed, local investigation of material behavior have recently been developed such as: image based modeling, virtual microstructure modelling, explicit microstructure modelling etc. Their common feature is representation of morphology of investigated microstructures in such a way that each important morphological feature is presented explicitly. The approach in the present work will be called by a unified term - the Digital Material Representation (DMR).

Recent research carried out by the principal investigator (PI) on development of this class of models, in particular based on the cellular automata method, have proven their advantages and immense capabilities in solving practical industrial issues (e.g. high temperature microstructure evolution, fracture initiation and propagation etc.) at the completely new level of computational accuracy.

**However, as mentioned, when digital material representation models of complex microstructures are considered, limitation to 2D computational space may influence quality of numerical predictions, far more than in the case of simple mean field models**. Such 2D DMR models, from definition cannot predict influence of geometrical heterogeneities in the third dimension. Presently there is lack of systematic research in the literature related to evaluation of influence of reduction in computational domain complexity to 2D space on DMR models predictions.

**The present research is thus directed towards these issues. Primary interest is put on fundamental study on the simplifications introduced in 2D models on results' accuracy with respect to reduction of priceless computing times. Evaluation of mentioned issues, is critical for further development of digital material representation concept.**