Microstructural mechanics consists in estimating the overall properties and local strain fields of representative volume elements of heterogeneous materials for instance by means of computational homogenization methods. Adopting the statistical approach for the definition of representative volume elements, a large number of simulations were performed for a broad range of material porosity values and mechanical loading in order to evaluate the yield locus and ductile fracture of metallic alloys [1].

Another important class of porous metallic materials with high void volume fractions is represented by metal foams. Microtomographic images are used to model the 3D microstructure of the foam and obtain a fine 3D finite element mesh. This detailed knowledge of the characteristic lengths and morphology of foams is used to calibrate a micromorphic constitutive model and simulate plasticity and fracture of nickel foams [2].

The last part of the presentation deals with the modeling of size effects in porous single crystalline metallic alloys. Plastic strain gradients in the matrix affect the growth of cavities. The intrinsic length scale involved in the proposed reduced order micromorphic crystal plasticity model interacts with the pore size and modifies the plastic flow in these highly anisotropic materials [3].