Elastic Properties of Highly Porous Plastic Foams Reinforced With Nanoparticles

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In order to enhance the mechanical properties of polymer foams, nanoparticles of different materials, sizes and shapes are being applied. For calculating the linear elastic constants of high-porosity, filled cellular plastics, orientational averaging the rigidity tensor of a structural element consisting of an air sheath and a load-carrying element in the form of a straight strut with a piecewise constant cross section is performed. The load-carrying element can resist the axial and shear loads and bending moments applied to its ends. It is assumed that the rigidity tensor $\mathbf{C}^*$ of the cellular plastic is equal to the orientational average of the tensor $\mathbf{C}^*$ with account of the orientational distribution $f(g)$ of these elements in the material:

$C = \langle C^* \rangle = \int_{O(3)} f(g) C^* dg,\ g \in O(3),$ where O(3) is the group of three-dimensional rotations.,

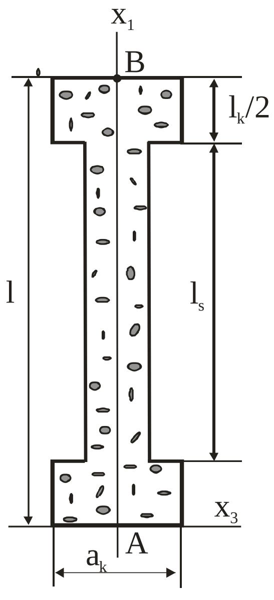

Fig.1. Platelet- shaped nanoparticles (in an increased scale) filling a polymer load-carrying element.

Each polymeric load-carrying element is considered to be filled with irregularly oriented shape-anisotropic nanoparticles: rods/fibers and platelets. The effective elastic constants of the polymer nanocomposite are determined by application of the method of orientational averaging of the elastic characteristics of transversely isotropic structural elements filled with unidirectionally oriented nano-rods or coplanarly placed platelets (e. g. montmorillonite). The superposition of elastic properties of the irregularly oriented structural elements is accepted, with account of their orientational distribution in the polymer.

References

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