

## NUMERICAL SIMULATION OF LCF OF STRUCTURE MATERIAL WITH INCLUSIONS

J.M. Temis<sup>1</sup>, Kh.Kh. Azmetov<sup>1</sup> and A.A. Lazarev<sup>1</sup>

<sup>1</sup>Central Institute of Aviation Motors, 2 Aviamotornaya st., Moscow, 111116, Russia,  
tejoum@ciam.ru

**Key Words:** *Material with inclusions, Low cycle fatigue, FEM simulation.*

The introduction of inclusions of various types into a base material give greatly enhanced mechanical properties of the resultant composite. These properties will depend on the properties of both the base and inclusion material and dimensions, geometrical form and disposition of the inclusion. These parameters and the parameters of the interface between base material and inclusion define fatigue strength under cyclic loading. Despite on improving of mechanical properties of structural materials with inclusions, the inclusion is a place of crack origin. Distributions of the stresses and strain is depended over inclusion size and form. The using of mathematical simulation methods detect new facilities of receiving the more likely material and inclusion combinations, it allows to limit the amount of experimentation, which is necessary, to produce successful materials.

Successful prediction of low-cycle fatigue of the structure materials depends on stresses and strains on the interface between base materail and inclusion and solution of several interrea ted problems: creation and developement of analitical models (loads, boundary conditions, materials models) which will adequately describe all aspects of deformation history; development of plasticity model adequate to the processes taking place during sing-alternating elastic-plastic deformation and the creation of fatigue criteria. The lifetime of low cycle fatigue is connected directly with plastic deformation process in stress concentration zones of structure materials. During sign-alternationd non-stationary non-elastic deformation the process of concealed damage accumulation take place in the material, leading to crack origin and evolution.

Technology of simulation of low cyclic fatigue of structure materials, which is based on FEM and use a number of models: material cyclic behaviour model, concerned with damage model [1,2] and «died» element model describing LCF crack evolution [2], are applied for numerical simulation of LCF of structure material with inclusions.

The result of numerical simulation of cycle tests of specimens with inclusions of various forms up to a failure is given. It is shown, that cyclic damage of basic material on the interface between one and inclusion is responsible for the number of cycles to failure.

### REFERENCES

- [1] I.V. Putchkov, Y.M. Temis, A.L. Dowson and D. Damri, Development of finite element based strain accumulation model for the prediction of fatigue lives in highly stresses Ti components. *Int. J. Fatigue.*, Vol. **17**, No 6, pp. 385–398, 1995.
- [2] Y.M. Temis, A.I. Fakeev and Kh.Kh. Azmetov, Numerical simulation of nonisothermal plasticity and thermomechanical fatigue of turbomachinery components. *Proc. of the XII Int. conf. on comp. plasticity. Fund. and Appl., Barselona, Spain*, pp. 1130–1141, 2013.