Accelerated numerical simulations of evolution of multilayered system subjected to thermal cycling

Dan Cojocaru and Anette M. Karlsson

University of Delaware

We consider failure mechanisms in multilayered systems subjected to cyclic loading, using an accelerated computational approach in the context of the finite element method. In particular, this paper is focused on simulating the cyclic degradation in films and coatings with evolving material properties. An accelerated finite element computation scheme is developed and implemented in the commercial software ABAQUS. The scheme takes advantage of the long term evolution of the structure's cyclic response by replacing portions of finite element computations by cycle jumps. The accuracy of the solution is maintained through a control function which calculates the appropriate jump length based on the non-linearity of the predicted long term evolution. In addition, a performed jump is validated by evaluating the results provided by the subsequent finite element analysis. Computational efficiency is assessed based on applications to finite element models of coating systems. Accuracy of obtained solutions is evaluated by comparisons with fully conducted finite element simulations. Aspects pertaining to implementation and possible improvements are discussed.