Multiaxial Creep-Fatigue Damage Evaluation for SUS 304 Stainless Steel Cruciform Specimen at High Temperatures

Shengde Zhang

High temperature components, like sodium container in a fast breeder reactor, undergo multiaxial creep-fatigue damage. An accurate estimate of creep-fatigue damage is essential for the safe operation and life extension of high temperature components. This thesis studies the creep-fatigue damage evaluation for SUS 304 stainless steel under a wide range of stress multiaxiality. The main conclusions obtained in the respective chapters are as follows.

In chapter 3， creep-fatigue tests were performed for cruciform specimens of SUS 304 strain less steel using four strain waveforms and three principal strain ratios, and the effects of the strain waveform and principal strain ratio are discussed. The strain waveform and principals strain ratio have a significant effect on the creep-fatigue life and the principal strain ratio reduces the creep-fatigue life.

Discussed in chapter 4 is the applicability of multiaxial creep-fatigue life prediction methods to the experimental data generated in the study in chapter 3. Since the stress-strain states cannot be measured experimentally for the cruciform specimens, they are evaluated by a finite element method. Linear damage rule is applied in combination with three multiaxial stress and three multiaxial strain parameters. The most suitable parameter for the creep-fatigue life prediction is the combination of the equivalent stress and strain based on crack opening displacement.

Creep-fatigue damage process is discussed in chapter 5. The stress multiaxiality enhances the crack initiation and void nucleation as well as their growth. The anisotropic void development is found under multiaxial stress condition and the damage evaluation taking account of the anisotropic development is needed for the creep-fatigue damage evaluation under multiaxial stress states.