Small scale cantilever creep of materials

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The integration of in-situ observations with load-displacement data has brought about a minor revolution in microscale mechanical testing. In the present instance, the non-linear deformation of a creeping cantilever with a spatially varying stress distribution is combined with digital image correlation (DIC) to obtain large data sets that link stress, strain and time from a single sample. The early work on bending creep was initiated by, amongst others, former students of Timoshenko in the 1930s and 40s. It has been rediscovered in recent times and made into a powerful tool with the addition of DIC [1-2]. Conventional uniaxial testing assumes a knowledge of stress and requires local strain determination. In contrast, the stress state in bending requires prior knowledge of the constitutive law that relates stress and strain rate / strain. This talk will illustrate different examples of the applications of this technique, including residual life assessments of boiler steels based on steady state creep rates [5], specimen size effects related to strain gradient effects in sub-millimetre cantilevers of aluminium, room temperature primary creep at stresses close to yield in titanium alloys and small samples of additively manufactured aluminium alloys. Future challenges, both in modeling for high throughput testing and in experimental procedures for extending the work to even higher temperatures are discussed.

References

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