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Hot forging process simulation for aerospace aluminum alloy using a modified Johnson-Cook equation

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In the aerospace industry, parts requiring tight dimensional tolerances and very high mechanical properties are often produced by forging. This forming process allows for an optimal use of the material and can produce high quality parts at a reasonable cost. Thanks to CAD techniques, it is now easier to predict flow profiles and in-process defects occurrence as well as wear of the forging dies. However, in order to determine the properties of the forged part with computer simulation methods, a good material constitutive law is a prerequisite. This paper presents a virtual manufacturing process modeling for the closed die forging of a workpiece performed with Abaqus. The hot closed die forging is a regular process applied to manufacture metallic components used in aerospace industry. In this forming process, the material flow and final properties depend on the microstructure evolution during the process that is why it is important to include the microstructure effects in the material model. Based on the stress-strain data measured experimentally, the material parameters of the standard (classical) Johnson-Cook constitutive model and of a modified Johnson-Cook constitutive law including the microstructure effects have been determined. The obtained simulation results are compared with the experimental results for validation.

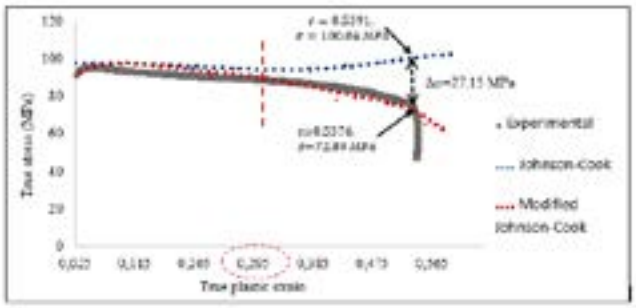

Figure 11: Comparison of classical Johnson-Cook stresses and modified Johnson-Cook stresses with the experimental compression test at 400°C

Recent Publications

1. Q Yang, Z Deng, Z Zhang, Q Liu, Z Jia and G Huang (2016) Effects of strain rate on flow stress behavior and dynamic recrystallization mechanism of Al-Zn-Mg-Cu aluminum alloy during hot deformation, Materials Science & Engineering A 662:204–213.
2. C Shi, J Lai and X Chen (2014) Microstructural evolution and dynamic softening mechanisms of Al-Zn-Mg-Cu alloy during hot compressive deformation, Materials 7:244-264.
3. H E Hu, L Zhen, L Yang, W Z Shao and B Y Zhang (2007) Deformation behavior and microstructure evolution of 7050 aluminum alloy during high temperature deformation. Materials Science and Engineering A 488:64–71.
4. U R Andrade, M A Meyers and A H Chokshi (1994) Constitutive description of work and shock hardened copper. Scripta Metallurgica et Materialia 30(7):933–938.

Biography

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