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Editorial

Quasi-Static and Dynamic Testing of Metallic Materials

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1. Introduction and Scope

Understanding the deformation of metallic materials at different states is essential in forming operations and under working conditions. The main motivation for increased knowledge about the mechanical response of materials is to ensure the robust and reliable production and use of components. In practice, that means to predict and avoid failure. No metallic materials can be considered fully homogeneous, as the microstructure in the form of grain morphology, constituent particles, precipitates or different phases strongly influence the performance. For metallic composites, reinforcements increase the anisotropic behavior, i.e., the properties are enhanced in specific directions, but are poor in others. This may lead to imperfections, like cracks and flaws that naturally impair the properties. In the recent decades, there has been an increased focus on the use and development of numerical models to predict the behavior of metallic materials. Input parameters for, and validation of, such models are of great importance to ensure the reliability and robustness of the models.

2. Contributions to the Special Issue

The current Special Issue encouraged both experimental and numerical original contributions that will elucidate the behavior of metallic materials in the range from quasi-static to dynamic conditions, and from micro-scale to full-scale component testing. Five manuscripts have been included in this Special Issue.

2.1. Digital Image Correlation

The Digital Image Correlation (DIC) technique has, in recent years, become a well-established tool for investigating deformation behavior. The DIC technique uses patterns on the material surface that provide markers to calculate the deformation field. The resolution of the technique is limited by the quality and size of the pattern. The optimization of both the physical settings like contrast and light, and post-processing of data is essential to obtain good results. In the work by Chen et al. [1], the authors have demonstrated that the DIC technique can be optimized to evaluate and give conservative predictions of the residual tensile strength in an aluminum alloy with multi-site collinear and non-collinear damage. The 2024-T4 alloy that was investigated is typically used in aircraft components and structures and is prone to multi-site damage. Paulsen et al. [2] took the DIC to a higher level and a much lower scale. Investigating a ferritic-pearlitic steel in situ using SEM, they pointed out possibilities and limitations of two preparation techniques for DIC. One technique was to use the etched microstructure and the pearlite lamellas as patterns. The other was the gold remodeling technique, which leaves a finely dispersed gold speckle pattern on the surface, giving an excellent combination of high contrast and spatial resolution at the sub-micron level.

2.2. Numerical Simulation of Structural Behavior

Some things are, in practice, impossible to measure directly, like the stress state of the material during deformation. Here, numerical simulations may provide us with valuable information and detailed analyses. As mentioned, no materials are completely homogeneous. Kossakowski [3] has done numerical simulations of microdamage evolution in a steel component. The initial damage was considered in the size range of what can be expected from pitting corrosion in structural components. Inhomogeneities and their effects on deformation behavior were also investigated by Liu et al. [4]. In this study, the material was a SiC fiber-reinforced laminated composite. The authors have, in this work, shown how the verification and validation of numerical models can be used to optimize the advanced structure of composite materials.

2.3. Dynamic Behavior at Different Temperatures

The behavior of age-hardenable aluminum alloys is strongly dependent on the thermo-mechanical process due to the formation of precipitates. In the work by Ye et al. [5], the mechanical properties under dynamic compressive loading were investigated in the temperature range from 25 to 400 °C. The precipitate size and number density depend on the deformation temperature. The interaction between precipitates and dislocations is found to vary with the strain rate.

3. Conclusions

This Special Issue, 'Quasi-Static and Dynamic Testing of Metallic Materials', covers a wide range of interesting research topics, from comparing experimental techniques to understanding the behavior of and optimizing advanced tailored composites. As guest editor, I believe that this Special Issue shows the importance of understanding the behavior of the metallic materials that surround us in our everyday life to ensure robust and safe materials.

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Conflicts of Interest: The author declares no conflict of interest.

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