Heterogeneous deformation during electromagnetic ring expansion test

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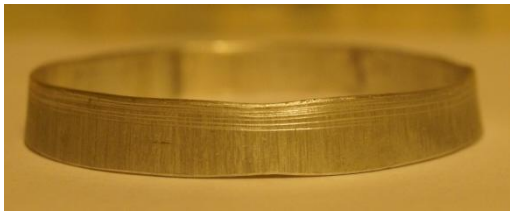
ABSTRACT

High speed events become attractive in manufacturing methods that significantly reduces the cost and energy requirements during the processes. Conventional manufacturing processes such as forging, forming, stamping and cutting of metals typically involve a strain rate of 10^2 – 10^4 s^{-1}. During advanced manufacturing methods such as high speed forming and welding processes, certain regions of materials could also experiences significantly high strain rate (> 10^4 s^{-1}). In order to understand the physical behaviours of materials and to design/control/optimise such manufacturing processes that requires an appropriate technique to capture the material's viscoplastic property under the high strain rate deformation. Therein, the electromagnetic ring expansion test becomes a promising method to characterize the material behaviours under the high strain rate deformation. The ring expansion is caused by Lorentz force that is generated due to the magnetic induction on the ring. However, the realistic nature of the electromagnetic ring expansion test is quite complex because of the coupling physics between electromagnetic-thermal-mechanical components.

Therefore, in this study we evaluate certain controlling parameters those govern the fundamental behaviour of the electromagnetic ring expansion test. Particularly the rotation and irregular deformation of the ring are noticeably observed and these phenomena require extra attention.



With the aid of LS-DYNA® package and concurrent experimental verifications are used to test the influencing factor of rotation and irregular deformation. The analysis shows that the asymmetry of axial compression and radial expansion caused by Lorentz force resulted from the asymmetry of the coil geometry. Following this detailed analysis, this paper proposes the methodologies to reduce the rotation and irregular deformation of the ring during the electromagnetic ring expansion test.

REFERENCES

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