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Application of Synchrotron X-ray Microtomography to Aluminum Foams

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Synchrotron X-ray microtomography has been utilized for the 3D characterisation of microstructure in the cell materials of aluminium foams. Tomographs, consisting of about 109 isotropic voxels with a maximum of 1.0 μm edge, were collected at the SPring-8 in Japan. A combination of high-resolution phase contrast imaging technique and several state-of-the-art application techniques has enabled the quantitative image analyses of micro-pore, intermetallic particles and grain boundary as well as the assessment of their effects on compressive deformation and fracture behaviours. 3D finite-element meshes were also generated to monitor local stress and strain distributions during both static and dynamic compression.

It was fairly obvious that the existence of the coarse micro-pores and their spatial distribution pattern in the cell walls would be a key issue to control the deformation behaviours of the aluminium foams. Crack initiation and propagation appeared to be unaffected by the existence of the intermetallic particles and the grain boundary despite its high particle volume fraction. Rather brittle fracture of a cell wall was induced by the existence of the coarse micro-pores in the case of aluminium foams alloyed with Zn and Mg, while ductile buckling of cell walls was a predominant mechanism in the case of pure aluminium foams currently available in the market. It was clarified both experimentally and numerically that local stress elevation occurs around the coarse micro-pores especially in the case of the dynamic loading. Cracking could be attributed to the local tensile stress generated by the reflection of stress waves at free edge (i.e. micro-pore/aluminium interface) despite the global compressive applied load. However, the deformation and damage behaviours have been identified far more complex than solid materials due to their three-dimensionally irregular cell structure acting as strong stress risers.

In the talk, newly developed techniques necessary for the study on aluminium foams will be explained, such as an in-situ material testing technique and local tomography technique by which small region of interest in a fairly large specimen can be observed with the maximum resolution.

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Al Foam Preparation by Calcium Carbonate Powder as Blowing Agent

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The Al foams were prepared by melting foaming method with calcium carbonate powder as blowing agent. In this processing, the viscosity of Al melt was increased by adding calcium particles and then the calcium carbonate powder is added into the Al melt by vigorous stirring. The results show that the foaming process of Al melt foam of calcium carbonate as blowing agent is much slower than that of titanium hydride and Al foam prepared by calcium carbonate powder has both smaller pore size and lower porosity than those made by titanium hydride, which indicate that the calcium carbonate is a possible substitute for titanium hydride as blowing agent to make metal foam.