# Compressive Energy Absorption Behavior of Porous Aluminum Structures

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## Background

- The porous AlSi10Mg-SiC composite material provides good mechanical properties and wear resistance, which is applied to lightweight structural components and tribological parts.
- The materials are mostly designed for energy absorption and impact resistance applications, where the mechanical properties are strongly influenced by the porosity, pore size, and SiC content in the materials.

## Objectives

- To find the influence of pore size on the energy absorption behavior of AlSi10Mg-SiC composite material.

## Experimental Method

- The samples were manufactured using a replication casting process, and the details of the process are mentioned in the reference [1].
- The porous structure is designed for an average pore size of 0.8 – 1.2 mm (or 800 – 1200 µm).
- The samples were tested using lubricated platens of a Zwick-Roell HA250 universal testing machine and were compressed up to 60% strain at strain rates of 0.01 or 0.001 $s^{-1}$ [1].

## Data Analysis Method

- There were three sample tests collected to determine the average stress-strain behavior [1].
- Using the theoretical expression as mentioned below, the strain rate sensitivity, energy absorption behavior, and energy absorption efficiency were calculated. The average values of $W$ and $\eta$ were provided in [1].

## Theory

Strain Rate Sensitivity[2],

$$m = \left.\frac{\partial \ln \sigma}{\partial \ln \dot{\varepsilon}}\right|_{\varepsilon,T}$$

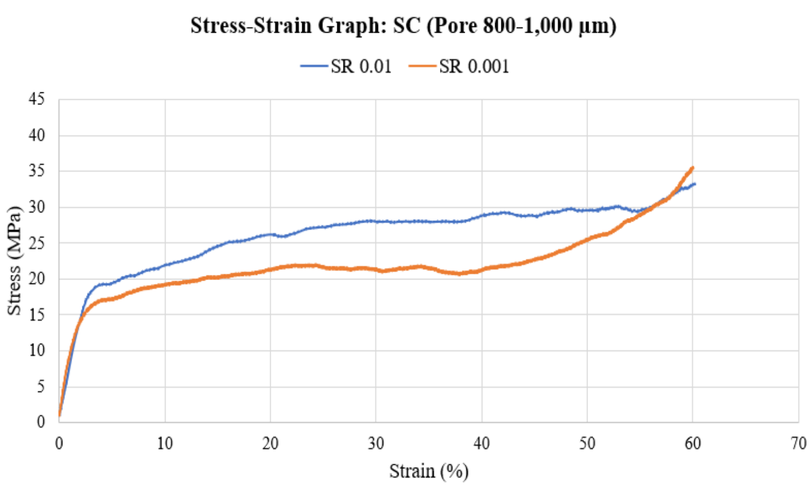
Here, $m$ is strain rate sensitivity (SRS), $\sigma$ is the compressive stress, and $\dot{\varepsilon}$ is the compressive strain rate

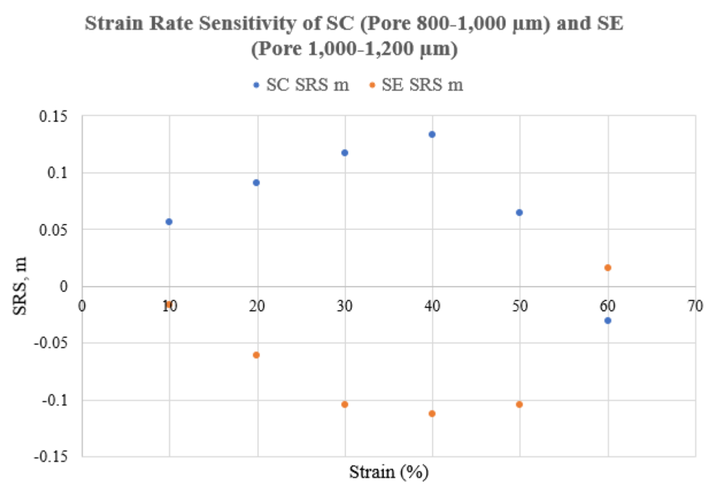
Energy Absorption [1], $W = \frac{1}{100}\int_0^{\varepsilon_0} \sigma d\varepsilon$

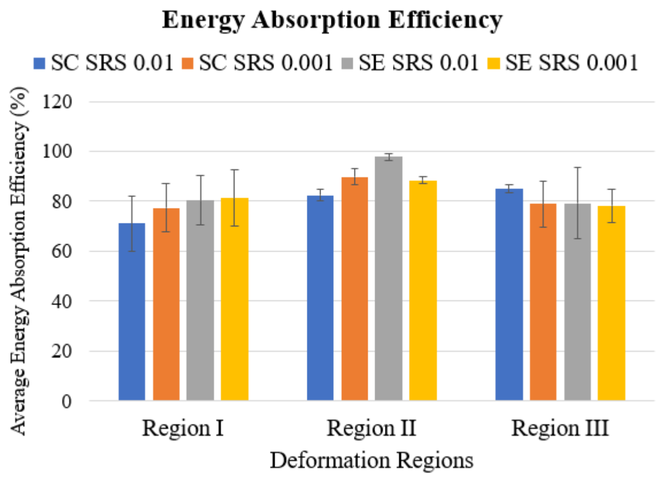
Energy Absorption Efficiency [1], $\eta = \frac{W(\varepsilon)}{\sigma_0.\varepsilon_0}10^4$

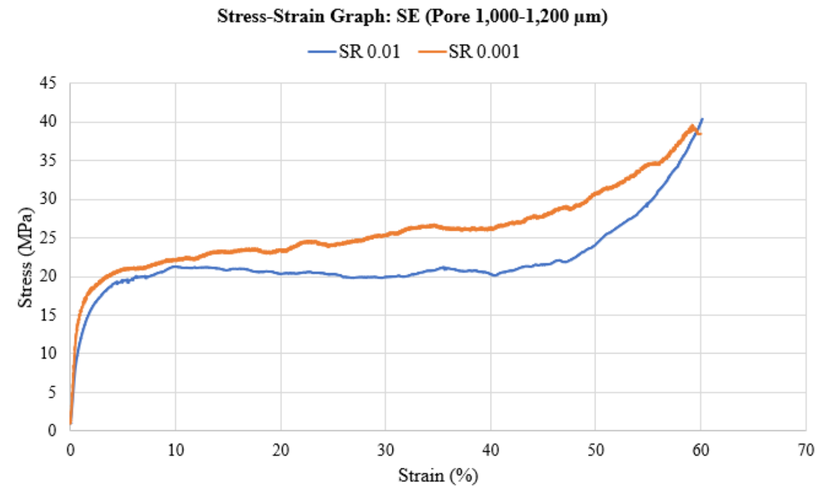
Here, $\sigma_0$ is the compressive stress at the upper limit of the compressive strain $\varepsilon_0$

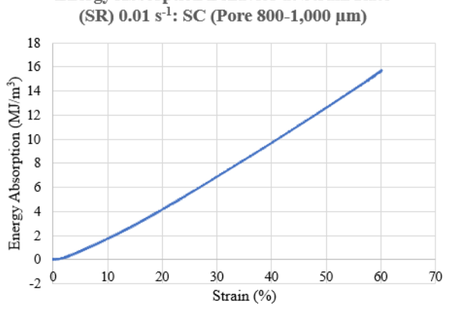
## Result

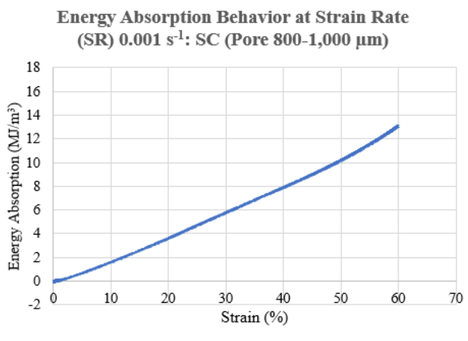


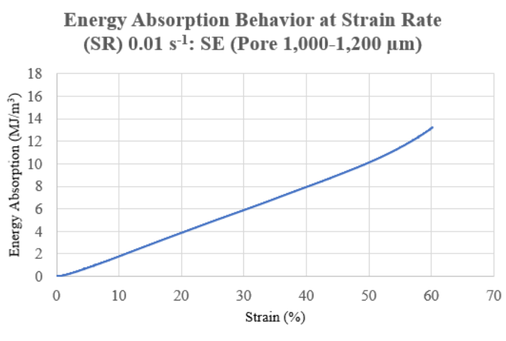



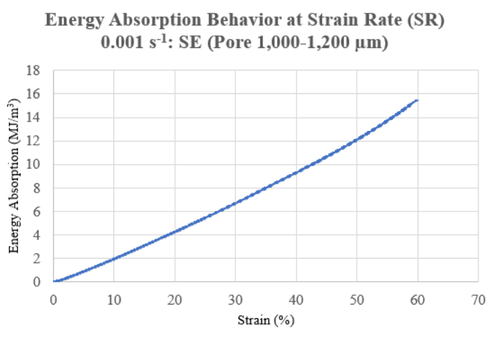




## Discussion

In this research, we worked with the average stress-strain behavior of each pore size and each strain rate to find the effect of pore size on the deformation behavior of AlSi10Mg-SiC.

- The plateau regions were observed between 10 to 50% strain regions.
- The strain rate sensitivity $m$ was calculated for each 10% deformation. The graph showed negative SRS values for the larger pore size deformation. Negative SRS can be found in the aluminum samples.
- The energy absorption efficiency was calculated for three regions in the deformation, such as region I: 0-20%, region II: 20-40%, and region III: 40-60%. The $\eta$ was comparatively for the region II deformation zone.

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2. Wang, X., Liu, Y., Shi, T., & Wang, Y. (2020). Mater. Sci. Eng. A, 792, 139776.