

## EFFECT OF ELEVATED TEMPERATURE ON THE COLLAPSE STRESS OF ALUMINUM FOAM: EXPERIMENTAL RESULTS

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### *Abstract*

The aim of this work was to investigate the effect of elevated temperature on the uniaxial compression behavior of aluminum foam of various densities. It was shown that the collapse stress rapidly decreases above 200°C, and that the effect of density on the collapse stress decreases above 300°C.

**Keywords:** aluminum foam, collapse stress, elevated temperature, density

## INTRODUCTION

The temperature stability of sandwich panels with aluminum foam core is important for special industrial applications. The potential applications of aluminum foam are thoroughly discussed in literature [1-8]. The aim of this work is therefore:

1. To investigate the influence of elevated temperature on the uniaxial compression behavior at a constant density.
2. To determine the effect of the density variation on the compression behavior at room and at higher temperatures.

The collapse stress, which determinates maximum operating load of the foam before the onset of plastic collapse, is used for this purpose.

## Experimental

Cylindrical samples ( $d = 30 \text{ mm} \times 30 \text{ mm}$ ) of density  $0.311 \pm 0.011 \text{ g.cm}^{-3}$  were used to estimate the dependence of the elevated temperature on the collapse stress. The samples were cut out from an aluminum foamed block with trade name Alporas® [9,10].

Uniaxial compression tests were conducted on a Zwick device with preloading 30 N and strain rate  $0.033 \text{ s}^{-1}$  at temperatures 25°C, 100 °C, 200 °C, 300 °C, 400 °C and 500 °C. The collapse stress, defined as the first stress peak before the onset of plastic collapse, was obtained from the uniaxial compression test [2,11].

To examine the effect of density at various temperatures, the samples of three different densities:  $0.217 \text{ g.cm}^{-3}$ ,  $0.259 \text{ g.cm}^{-3}$  and  $0.311 \text{ g.cm}^{-3}$  were tested at 25°C and at 300°C. The complete list of samples is shown in Table 1.

Tab.1. List of tested samples.

Temperature [°C]	Density [g·cm <sup>-3</sup> ]	Collapse stress [MPa]
25	0.213	1.04
25	0.218	1.13
25	0.255	1.54
25	0.252	1.44
25	0.307	1.74
25	0.325	1.83
100	0.321	1.71
100	0.297	1.62
200	0.321	1.62
200	0.292	1.42
300	0.217	0.88
300	0.217	0.85
300	0.259	0.90
300	0.259	0.95
300	0.316	1.02
300	0.311	0.95
400	0.321	0.62
400	0.297	0.63
500	0.297	0.34
500	0.311	0.34

## RESULTS AND DISCUSSION

The effect of the elevated temperature on collapse stress is shown in Fig.1: the collapse stress decreases slightly between 25°C and 200°C and steeply above 200°C. While relative error of collapse stress between 25°C and 200°C is only 18 % (1.78 MPa for 25°C and 1.47 MPa for temperature 200°C); it is more than 75% between 200°C and 500 °C (1.47 MPa for 200°C and 0.34 MPa for 500°C) – see [14,15]. From the abovementioned it is clear that significant loss of collapse stress starts above 200°C, and therefore the sandwich core panel with aluminum foam filling can be used in applications up to 200°C. However, long-term testing at this temperature is appreciated.

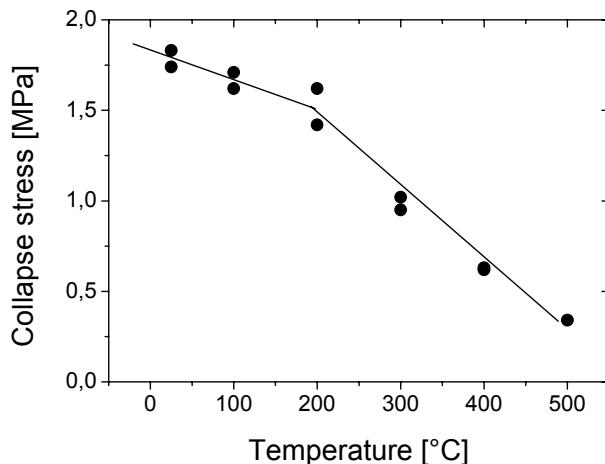


Fig.1. Effect of the temperature on the collapse stress.

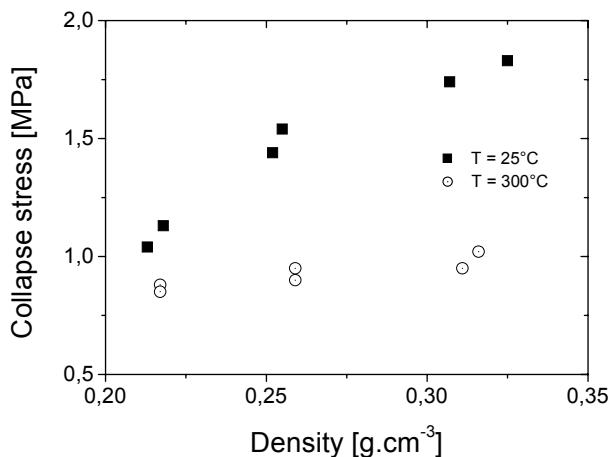


Fig.2. Effect of the temperature and density on the collapse stress variation.

Figure 2 shows the effect of density on the collapse stress at 25°C and at 300°C. Obviously, the collapse stress decreases with a decrease of density [11-15] for both temperatures, which is in agreement with the study. However, the density effect on the collapse stress at 300°C is more significant with that obtained at 25°C. The collapse stress at 25°C decreases 40% from 1.78 MPa (0.316 g·cm<sup>-3</sup>) down to 1.09 MPa (0.216 g·cm<sup>-3</sup>), while decrease at 300°C is only 12% (0.99 MPa at 0.314 g·cm<sup>-3</sup> and 0.87 MPa at 0.217 g·cm<sup>-3</sup>) due to higher mobility of matter in the cell walls on micro-scale at 300°C.

## CONCLUSIONS

A significant decrease of collapse stress occurs above 200°C.

The effect of the density on the collapse stress variability is lower at 300°C in comparison with that obtained at 25°C. It can be therefore suggested that the aluminum foam used in applications at a high operating temperature (300°C) can be designed with a lower density.

## Acknowledgements

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