Thermal Degradation of Foam cored Sandwich Structures

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Background, Motivation & Aim

•Polymeric foam cored sandwich structures are being used widely in aerospace, naval, transportation and civil engineering industries.

•The mechanical properties of polymeric foam core materials may experience significant degradation in their properties at elevated temperatures due to the viscoelastic nature .

•The degradation of foam core material can exert a significant influence on the linearity and stability of the sandwich structure behaviour.

Objective:

•Develop a qualified methodology to identify the degradation of polymeric foam core materials with temperature.

•Construct an experimental apparatus to investigate the sandwich structure mechanical behaviour subjected to a uniform and gradient thermal condition.

Testing Apparatus

Initial tests have been conducted to study the foam tensile and compressive properties at elevated temperature as shown in fig.3. The foam specimen is PVC Divinycell H100. Digital Image Correlation (DIC) is used here to measure strain on the surface of the specimen.

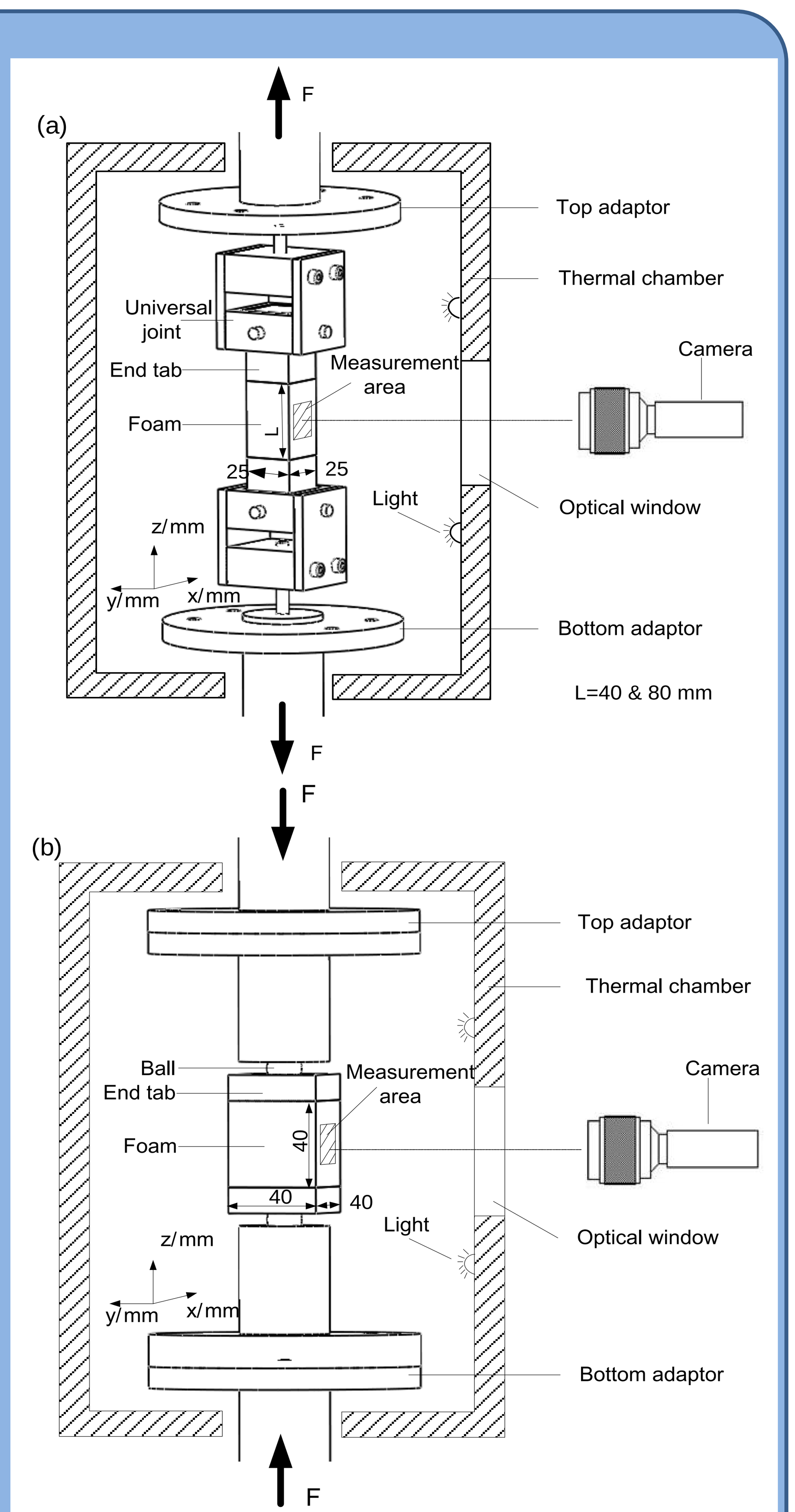


Figure 1: Testing Apparatus a) Tension; b) Compression

Unknown factors:

•Strain distribution
•DIC precision
•Alignment condition
•Window influence on DIC

DIC (Digital Image Correlation)

•Strain computed by DIC depends significantly on the subset size.

•64 x 64 pixel subset brings nosier strain.

•256 x 256 pixel subset over smoothes the non-uniform strain.

•128 x 128 pixel subset introduces an optimised strain distribution.

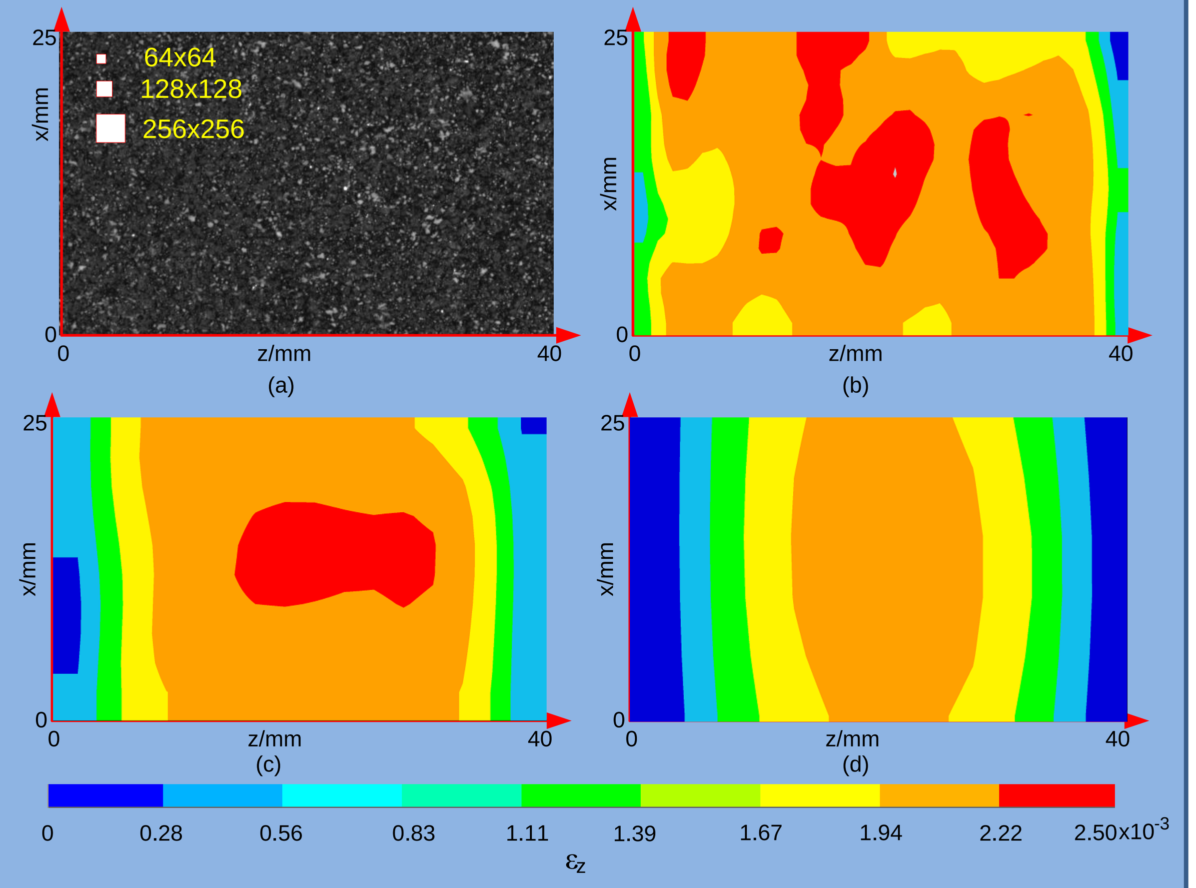


Figure 3: Strain computed by DIC a) raw image b) 64 x 64 c) 128 x 128 d) 256 x 256

Alignment identification

The alignment condition was identified by measurement of the strain on the two opposite surfaces simultaneously, and any bending alongside the tensile & compressive load can be quantified.

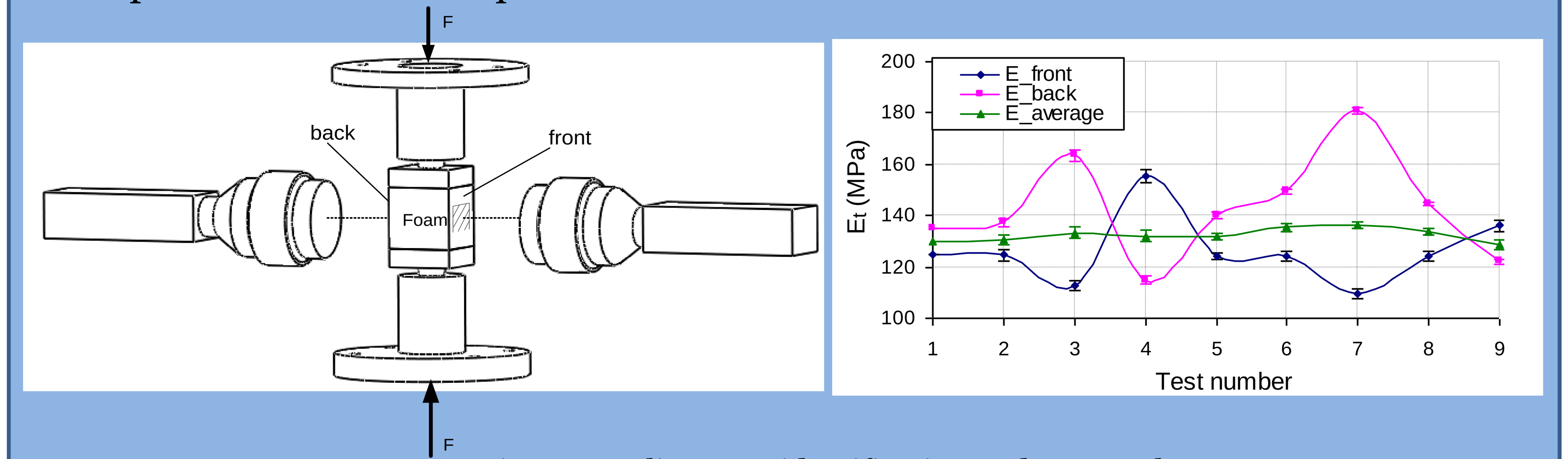
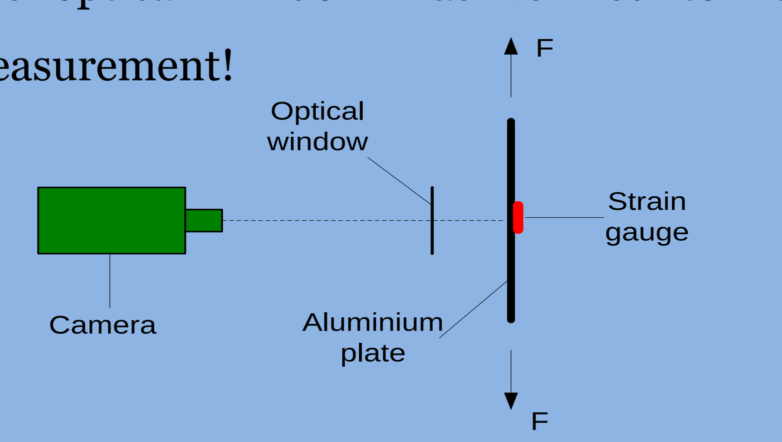


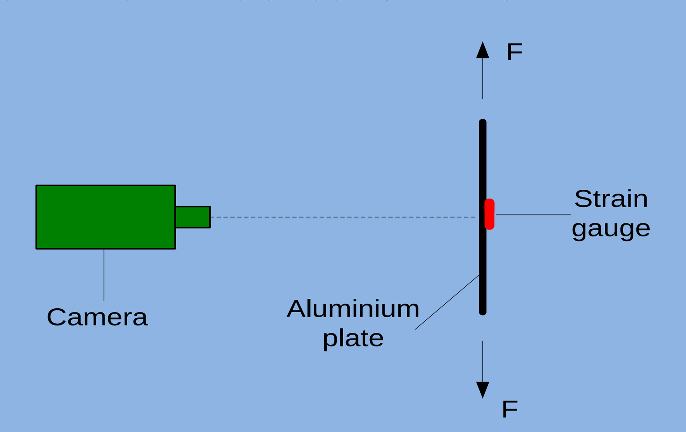
Figure 4: Alignment identification and test results

Window influence on DIC

The optical window was verified to have little influence on the 2D DIC measurement!



	Test1	Test2	Test3
E-strain gauge (GPa)	65.35	65.38	65.45
SD (GPa)	0.02	0.03	0.03
E-DIC (GPa)	64.66	66.75	63.00
SD (GPa)	1.83	1.42	1.63



	Test4	Test5	Test6
E-strain gauge (GPa)	65.50	65.71	63.92
SD (GPa)	0.03	0.03	0.02
E-DIC (GPa)	64.39	66.25	65.54
SD (GPa)	0.78	0.56	0.76

Strain distribution

Non-uniform strain is found, and the uniformity depends on the specimen dimension and properties.

$$\varepsilon_{surface} \neq \varepsilon_{bulk}$$

Surface strains need to be corrected to the bulk average strain to derive accurate moudli and Poisson's ratio.

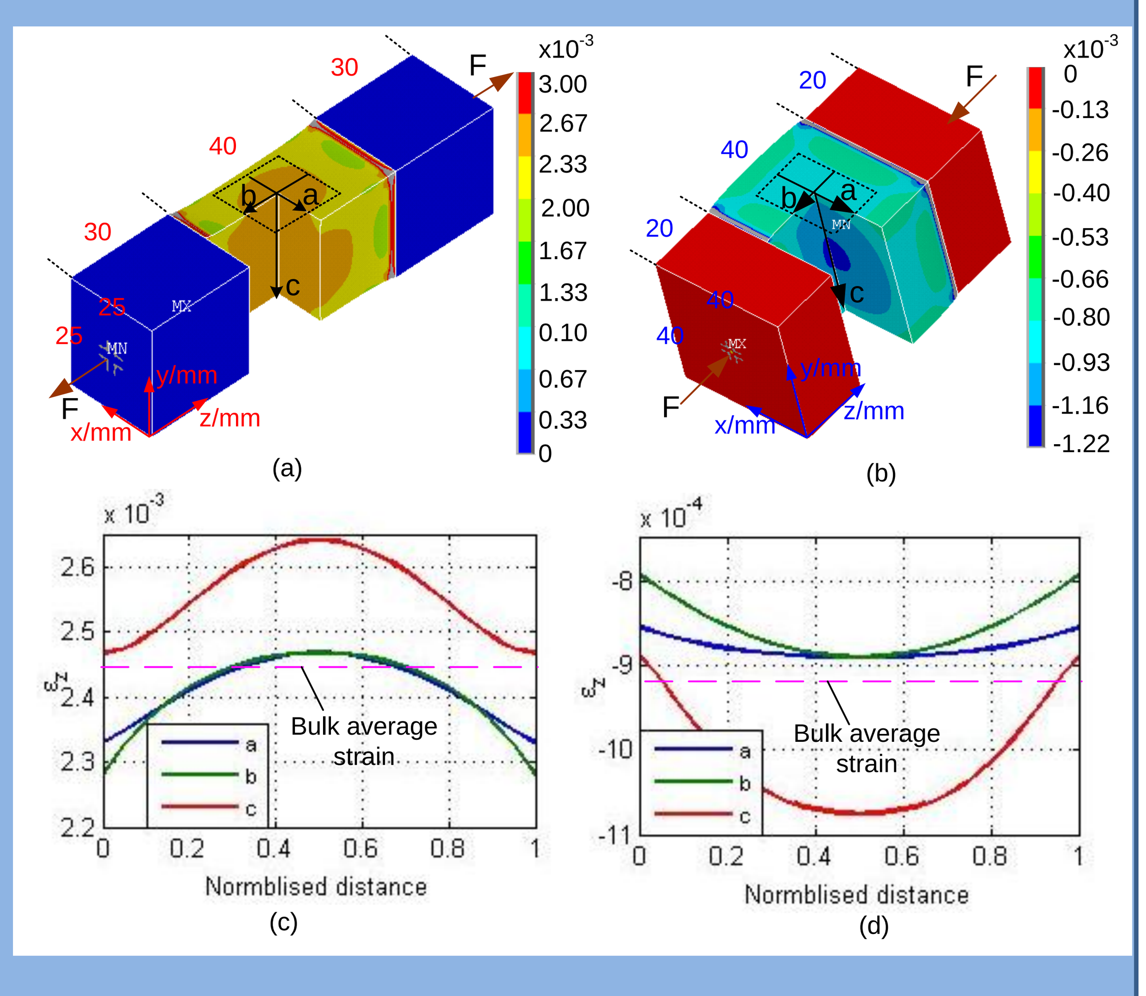


Figure 2: Strain distribution

Test results

•A linear degradation was found from 35° C to 65° C, and non-linear from 65° C to 90° C.

•The moduli decrease significantly after about 65° C .

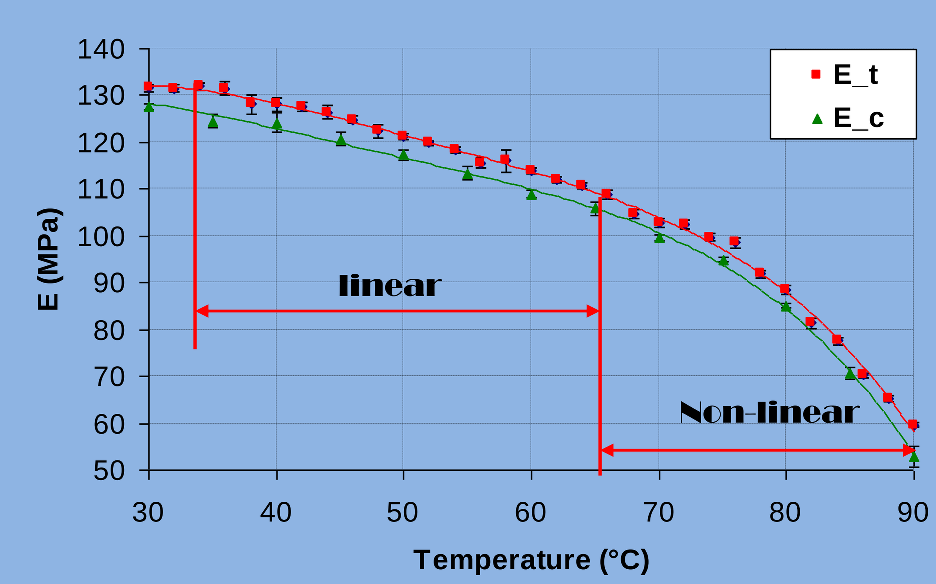


Figure 5: Alignment identification and test results

Conclusion

A reliable methodology is proposed to obtain the thermal degradation of the linear elastic properties of foam core materials using non contact optical extensometry.