POST-CURE COMPRESSION AS A VOID REDUCTION TECHNIQUE FOR THERMOSETTING COMPOSITES

Y. K. Hamidi[*], D. V. Rey, K. A. Olivero[#*], L. Aktas[*], and M. C. Altan[*]
Composite Materials Research Group
School of Aerospace and Mechanical Engineering University of Oklahoma
Norman, Oklahoma, 73019
(405) 325 1737
altan@ou.edu ABSTRACT

Composite materials often suffer from process-induced defects such as voids that lower their overall performance and thus limit their wider application. Void formation mechanisms and detrimental effects of voids on mechanical properties of composite parts have been studied extensively. In contrast, limited void reduction strategies are available for the industry. In this study, post-cure compression is proposed as a void reduction technique for thermosetting composites.

A resin transfer molded composite disk is fabricated by injecting a thermosetting resin into center-gated mold cavity preloaded with randomly-oriented glass fiber preform. After cure, void content is studied at 25.4 mm (1") and 50.8 mm (2") away from the injection gate of the 76.2 mm (3")-radius composite disk. Two adjacent samples are obtained from each location; the first is utilized as a baseline and the second is compressed at 70°C, slightly above the glass transition temperature, until reaching 6% compression in thickness. Void content, shape and size in each specimen are obtained via microscopic image analysis. Resulting level of voids as well as void morphologies from the four samples are compared in order to assess post-cure compression effects.

Initial void content is measured at 2.13%. Post-cure compression is observed to induce a 37.8% decrease in void content down to 1.33%. Considerable difference is also observed in void morphology. Voids become smaller after compression with almost 27% decrease in the average void size, from 44.7 μm down to 32.7 μm. With respect to void shape, voids become more elongated after compression as the so-called shape ratio decreases from 0.85 to 0.73. Circular voids dropped from 42.3% in the baselines to 32.7% in the compressed samples. In contrast, elliptical and irregular void frequencies increased by 8.3 and 56.7%, respectively. Post-cure compression is thus found to be applicable to thermosetting composites for void reduction. However, combining post-cure compression with other void reduction techniques such as vacuum assistance and packing might yield higher void reduction rates and lower the occurrence of irregular voids.

[*] Member, ASME
[#] Present address: OC-ALC, Tinker AFB, Oklahoma City, OK

Downloaded from SHAREOK. Persistent Handle URL: https://hdl.handle.net/11244/33183

References

1. Abraham D., Matthews S. and, Mcllhagger R., *Composites Part A*, 29, 795, 1998.
2. Hamidi Y. K., Altan M. C. and Grady B. P. Polymer Composites. In: *Encyclopedia of Chemical Processing*, Taylor & Francis 2313-2322. 2005.
3. Shojaei A., Ghaffarian S. R., and Karimian S. M. H., *Polymer Composites*, 24(4), 96, 2003.
4. Judd N. C. W., and Wright W. W., *SAMPE Journal*, 14(1), 10, 1978.
5. Hamidi Y. K., Aktas. L. and Altan. M. C. *Polymer Composites*. 26(5):614-627. 2005.
6. Ghiorse, S. R., *SAMPE Quarterly*, 24(1), 54, 1993.
7. Hamidi Y. K., Aktas L. and Altan M. C. *Composites Science and Technology*. 65(7-8):1306-1320. 2005.
8. Hamidi Y. K., Aktas L. and Altan M. C. *Journal of Engineering Materials and Technology*. 126(4): 420-426. 2004.
9. Goodwin A. A., Howe C. A., and Paton R. J., In: *Proc. of ICCM-11, Australian Composite Structures Society*, M. L. Scott, Ed., Vol. IV: 11, 1997.
10. Olivero K. A., Hamidi Y. K., Aktas L. and Altan M. C. *Journal of Composite Materials*. 38(11): 937-958. 2004.
11. Harper B. D., Staab G. H., and Chen R. S., *Journal of Composite Materials*, 21, 280, 1987.
12. Barraza, H. J., Hamidi, Y. K., Aktas, L., O'Rear, E. A. and Altan, M. C. *Journal of Composite Materials*. 38(3): 195-226. 2004.
13. Hamidi Y. K. and Altan M. C. *Journal of Materials Science Letters*. 22(24): 1813-1816. 2003.
14. Stabler W. R., Tatterson G. B., Sadler R. L., and El-Shiekh A. H. M., *SAMPE Quarterly*, 23(1), 38, 1992.
15. Olivero K. A., Barraza H. J., O'Rear E. A., and Altan M. C., *Journal of Composite Materials*, 36(16), 2011, 2002.
16. Hoppel C., Bogetti T., and Newill J. F., In: *Proc. of the American Society for Composites*, 1094, 2000.
17. Patel N., and Lee L. J., *Polymer Composites*, 16(5), 386, 1995.
18. Mahale A. D., Prud'Homme R. K., and Rebenfeld L., *Polymer Engineering and Science*, 32(5), 319, 1992.
19. Patel N., Rohatgi V., and Lee J. L., *Polymer Engineering and Science*, 35(10), 837, 1995.
20. Rohatgi V., Patel N., and Lee J. L., *Polymer Composites*, 17(2), 161, 1996.