FIBER OPTIC SENSORS: NEW TOOLS FOR POLYMER PROCESSING

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Introduction

Fiber optic sensors were first developed few decades ago for markets where no other sensing solutions existed, such as applications where high electromagnetic interferences (EMI) could be present. Typical applications were for instance temperature measurements in microwave ovens or in high power transformers, strain measurements in electrical welding jaws, pressure measurements for medical applications... If insensitivity to EMI is probably the most interesting advantage of such sensors, other interesting advantages are now being considered: since optical technologies proved to be reliable and accessible, new applications are emerging where reduced size or geometry of such sensors could be the most interesting features. The comprehension of all fiber optic sensor advantages opens now new markets.

Applications examples in polymer processing

We present here few possible examples of applications where commercially available fiber optic sensors (see www.fiso.com) could be used as new tools to help for the development of polymer processing. For instance miniature fiber optic pressure sensor (Ø ~0.5 mm) could be used to help optimizing polymer injection molding designs by measuring pressure at key positions[1]. Additional critical injection information could also be obtained with localized fiber optic temperature sensor. With selected pressure and temperature measurements, injection processing parameters could be optimized and monitored more easily.

Point pressure sensors could also be used to measure normal force for rheology studies of fluid polymers and thus provide useful parameter for instance to help understanding or monitoring chemical polymerization processes. For such fluid polymers, additional information could also be obtained with single point refractive index sensors.
Fiber optic strain sensors could be embedded into casted or injected polymers or into composite structures[2] without perturbing much the material mechanical properties as their size is among the smallest available. They could help to determine residual or induced stresses in final polymeric structures during fabrication or during normal use. Again the small size as well as the cylindrical geometry of the fiber optic sensor could be advantageously exploited.

More interestingly, recent works in microwave chemistry applied to polymer science[3-5] shown that better properties and faster polymerization time could be achieved if a good control of reaction temperature or pressure is achieved. Due to the presence of microwaves interferences, only fiber optic sensors could be used to measure temperature or pressure during continuous microwave heating since traditional electric sensors can not perform in such harsh environment.

References

1. Bur A.J. & Mattson B. *Mat. Techn.* (1995) **Vol. 10 n°1**, pp. 5-8, “A multi-functional optical sensor for monitoring and controlling polymer injection molding”
2. Wang W.P. et al. *Appl. Compos. Mat.* (1997) **Vol. 4**, pp. 187-195, “Fiber optic bend sensor for in-process monitoring of polymeric composites”
3. WiesBrock F. et al *Macromol. Rapid Comm.* (2004) **Vol. 25 n °20**, pp. 1739-1764 “Microwave-assisted polymer synthesis: State-of-the-art and future perspectives”
4. Balkarransingh Degamber & Gerard Franklyn Fernando *IEEE Sensors J.* (2004) **Vol. 4 n°6**, pp. 713-721, “Process monitoring of a thermosetting resin using optical-fiber sensors in a microwave environment”
5. Lye S.W. & Boey F.Y.C. *Mater. Manuf. Proc.* (1994) **Vol. 9 n°5**, pp. 851-868 “PC-based monitoring and control system for microwave curing of polymer composites”