Production of polymer/clay nanocomposite foams with improved fire behaviour using supercritical fluid technology

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The **aim of this work** is to improve poly(styrene-co-acrylonitrile) (SAN) foams burning behaviour by adding a few percent of lamellar inorganic nanofillers of the montmorillonite type. The foams are produced either in batch or by a continuous process using supercritical CO_2 as the foaming agent.

1. Batch foaming with $scCO_2$ and fire tests

Nanocomposites preparation: SAN/3wt%clay nanocomposite was prepared by melt blending a *home-made pre-exfoliated nanoclay* masterbatch (MB30B) into SAN. MB30B was in-situ synthesized in $scCO_2$ by polymerizing ε-caprolactone inside the galleries of Cloisite® 30B, a commercial organoclay. The details about the preparation and characteristics of the masterbatch and the resulting nanocomposite can be found in published papers[1,2].

Nanocomposites foaming: Foaming was performed by saturating the sample with CO_2 at 300bar and 40°C for 22h in a high pressure vessel. Then, the pressure was rapidly released and the saturated samples were dipped in a 100°C bath for 3min to allow foaming. Finally, the foams were quenched in an ice/water bath for 10min.

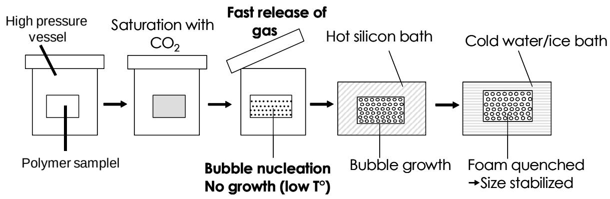

Fig.2: Two-step batch foaming process with $scCO_2$.

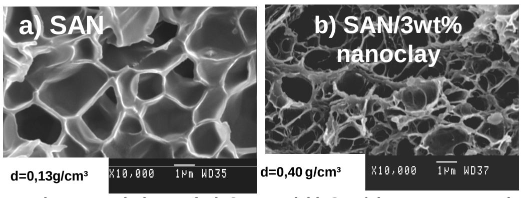

Fig.1: Morphology of a) SAN and b) SAN/clay nanocomposite foams as observed by scanning electron microscopy (SEM).

Fire test: The fire behaviour of SAN and SAN/clay foams has been evaluated qualitatively by burning the sample with a lighter.

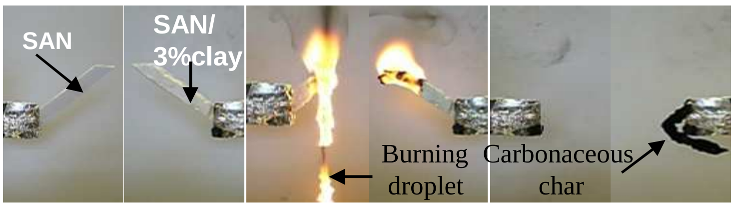

Fig.3: Qualitative fire tests performed with SAN and SAN/clay nanocomposite foams.

2. Continuous foaming with $scCO_2$ and fire tests

Fig.4: Single-screw extruder designed for supercritical fluid injection, used for continuous polymer foaming.

Nanocomposites foaming: MB30 is first melt blended with SAN in a semi-industrial scale twin-screw extruder[3]. Then, the pelletized nanocomposite is introduced in the single-screw extruder (Fig.4) at 180°C and CO_2 is injected (200bar) at the middle of the screw. Melt temperature is gradually reduced until 145°C at the exit noze to stabilize the cellular structure.

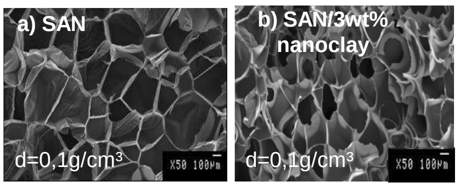

Fig.5: Morphology of SAN and SAN/clay nanocomposite foams prepared by continuous foaming as observed by scanning electron microscopy (SEM).

Fire test: see above for details.

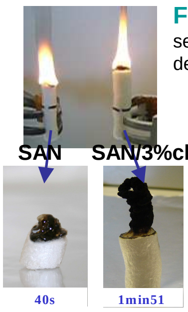

Fig.6: Qualitative fire tests performed with SAN and SAN/clay nanocomposite foams.

Conclusions

Adding only 3wt% of well-dispersed nanoclay significantly enhances SAN foam burning behaviour:

- ✓Longer burning time
- ✓No burning droplet during combustion
- ✓Resistant carbonaceous char formed

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References

1. L. Urbanczyk, C. Calberg, F. Stassin, M. Alexandre, R. Jérôme, C. Jérôme, C. Detrembleur, *Polymer*, **2008**, 49, 3979
2. L. Urbanczyk, C. Calberg, S. Benali, S. Bourbigot, E. Espuche, F. Gouanvé, Ph. Dubois, A. Germain, C. Jérôme, C. Detrembleur, M. Alexandre, *J. Mater. Chem.*, **2008**, 18, 4623
3. M. Mainil, L. Urbanczyk, C. Calberg, A. Germain, C. Jérôme, S. Bourbigot, J. Devaux, M. Sclavons, *Pol. Eng. Sci.*, **2009**, Accepted for publication