INJECTION MOLDING OF MICROCELLULAR POLYMERS

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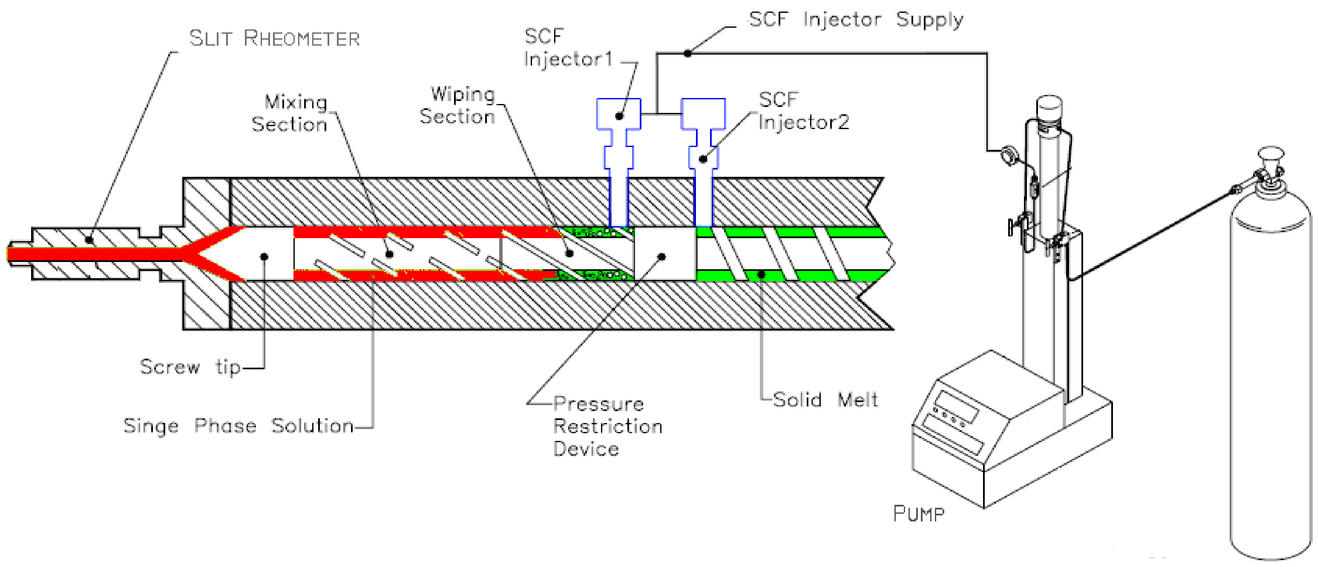
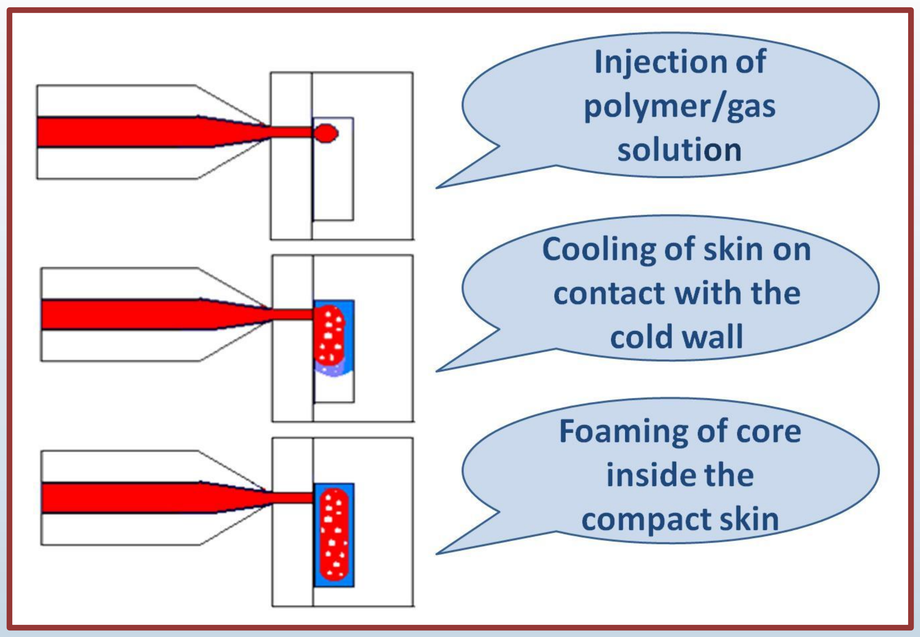
INTRODUCTION

The **Microcellular Injection Molding** is a relatively new process used to obtain light molded parts having good mechanical properties. In this work, a blowing agent was injected inside the cylinder of the injection molding machine by a pump connected to a gas supply and mixed with the polymer. The gas/polymer solution was injected into the cavity through a **hot runner** with shut-off nozzle and parts having a cellular core inside an integral skin were produced.

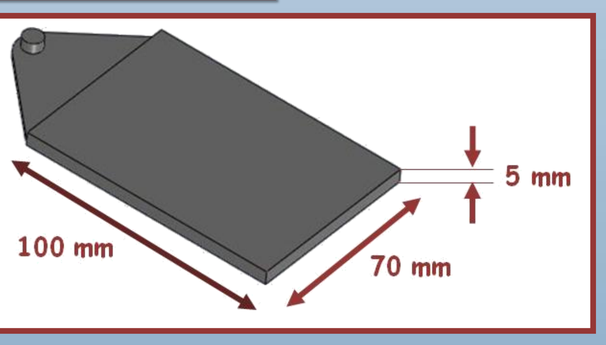




MATERIALS

- A general purpose polystyrene (**aPS**) STYRON 678E.
- **Nitrogen** under high pressure and temperature to reduce viscosity and glass transition temperature of polymer melt.

MOLD GEOMETRY



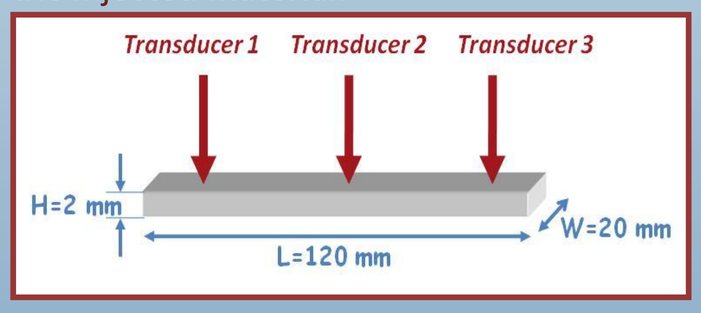
EXPERIMENTAL CONDITIONS

The experiments were performed by varying the various process variables in order to study their effect on the viscosity and on the density reduction of injected material.

$T_{injection}$ [°C]	220, 240
T_{mold} [°C]	30
Dosage [mm]	60, 90
Dosage speed [rpm]	200
Counter pressure [bar]	2
Injection speed [%]	5, 10, 20, 40, 80, 100
Gas pressure [bar]	0, 40, 60, 80, 100
Cavity thickness [mm]	5, 10

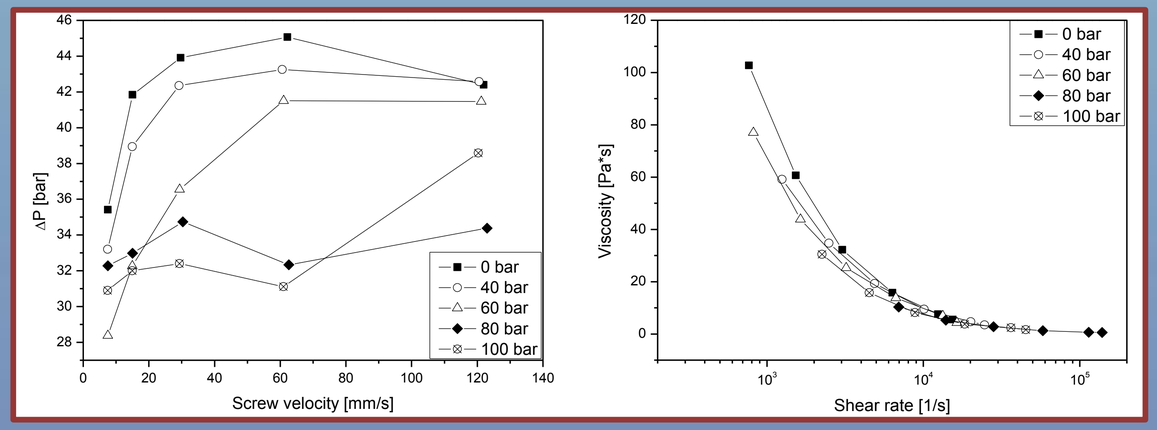
RHEOLOGICAL MEASUREMENTS

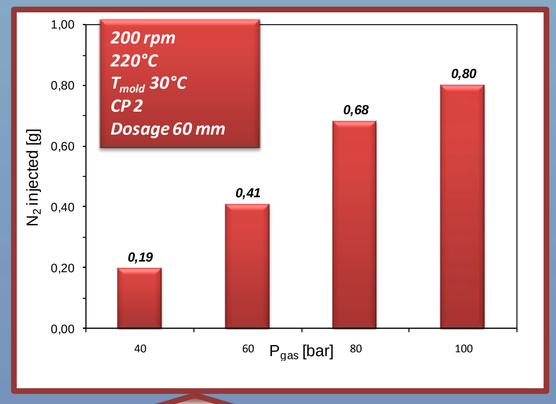
The nozzle of the injection molding machine modified to host a **slit** with three **pressure transducers** so that in-line rheological measurements could be carried out. This allowed to measure the effect of dissolved gas on the viscosity of the injected material.

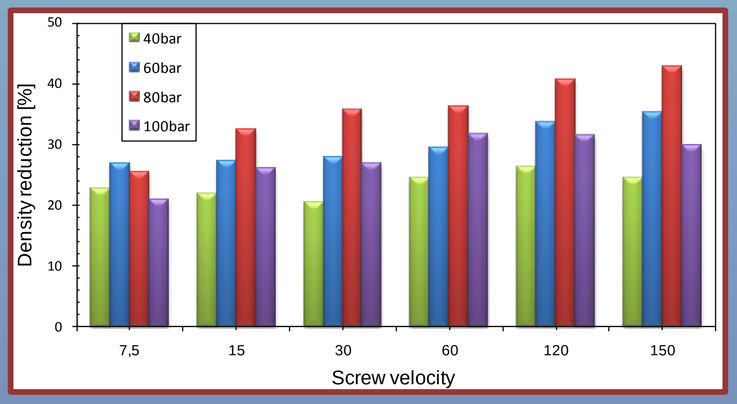


RESULTS AND DISCUSSION

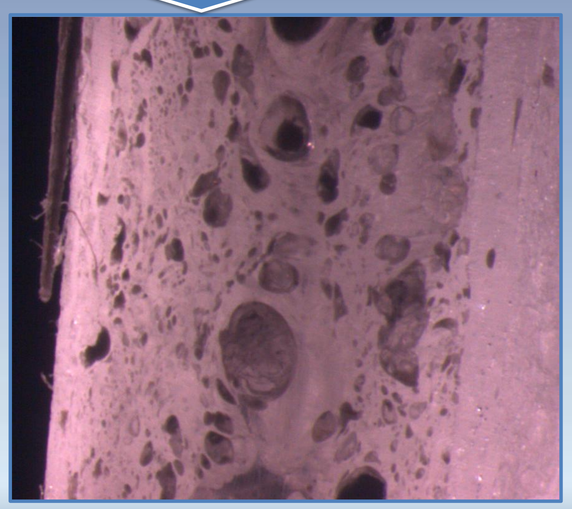
The “Data Flow" system allows the acquisition of the pressure data by the three transducers and of the screw position during the cycle. The shear rate and viscosity are calculated from the differences in pressure between the transducers. On increasing the amount of gas injected, we measure a reduction of the polymer/gas solution viscosity and also a decrease of density with respect to the unfoamed samples in the same experimental conditions.



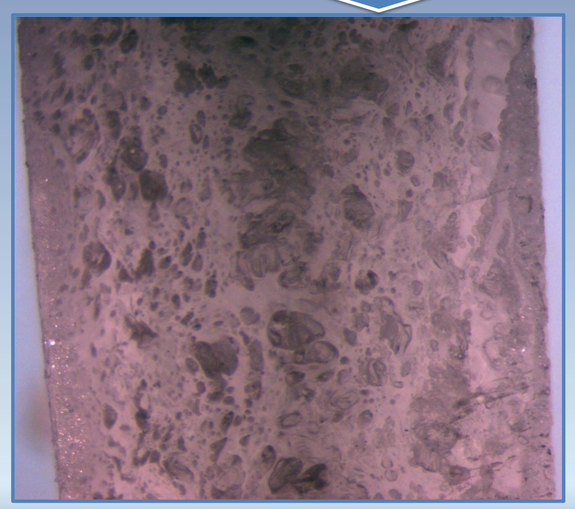




Gas Pressure : 40 bar
Injection Velocity : 80%



Gas Pressure : 80 bar
Injection Velocity : 80%



The volumetric pump allows to measure the amount of gas injected for each dose of polymer at the different pressures of gas injection.

FUTURE WORK

Microcellular injection molding of **biodegradable polymers** with physical blowing agent: the viscosity and glass transition temperature reductions shall widen the processing window.

Identification of correlation between rheological properties, morphology and mechanical properties of structural foams.

CONCLUSIONS

In this work, a system for microcellular injection molding has been developed. This system is able to:

- control the amount of gas injected into the polymer
- evaluate the rheological behavior of the gas/polymer solution.

Some tests have been carried out with the aim of:

- optimizing the morphology of the foamed samples
- controlling the main variables of the microcellular injection molding process.