Modelling of the high pressure die casting process

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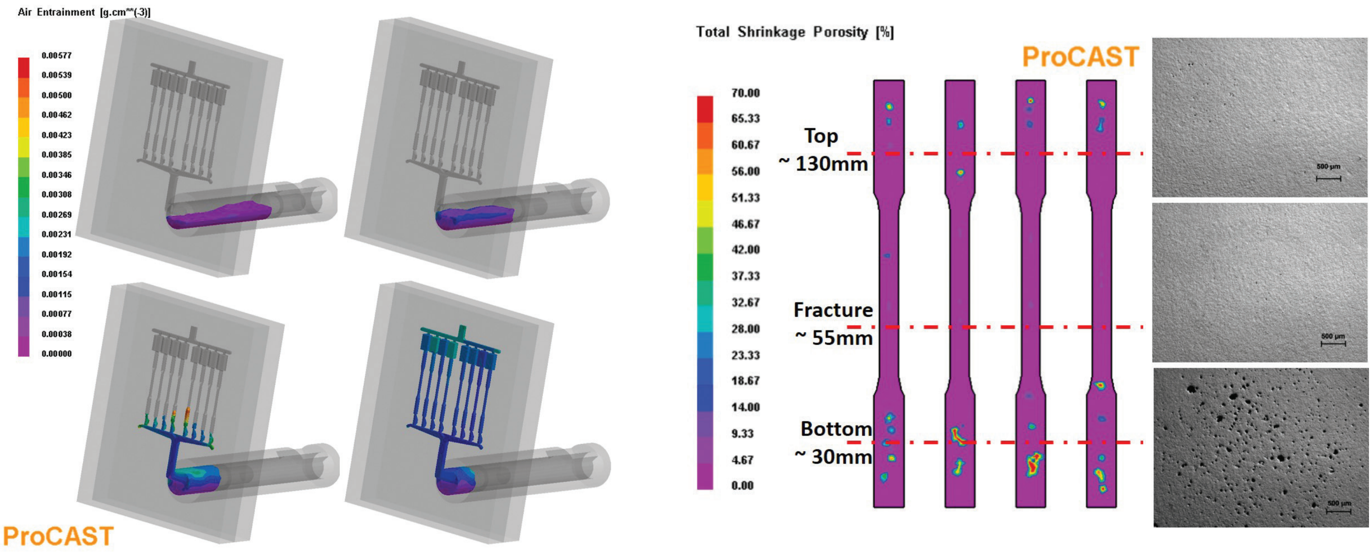
Numerical simulation is a powerful and cost-effective tool to optimise manufacturing processes and to gain access to quantities that are difficult to obtain experimentally.



(a) (b)

FIGURE 1. Simulation of flow and air entrainment during high pressure die casting of Silafont-36 test samples (a) simulated (centre) and (b) micrographs (right) showing porosity at three locations.

A new approach for the simulation of the high pressure die casting (HPDC) process has been initiated at BCAST to investigate flow and heat transfer, as well as microstructure and defect formation in HPDC parts during manufacturing. The simulations are performed initially to help design experiments. The long-term objective is to understand the variability of mechanical properties in HPDC parts, which is a major concern to achieve weight reduction through lighter designs. The approach is based on a combination of experiments and simulation.

The HPDC of tensile test samples of an aluminium alloy, Silafont-36, has been simulated using the finite element casting software ProCAST. As shown in Figure 1a, during the first stage of injection, when the piston moves at a low speed, a shallow wave is formed at the free surface of the melt. During the second stage, the piston velocity increases and the melt is injected into the die at high speed. The simulation predicts the evolution of different physical quantities such as the melt velocity, temperature and solid fractions. In addition, it provides insight into the distribution of defects. In Figure 1a the colour maps represent the amount of entrapped air. These results were obtained by using the air pressure and flow in the die, including the role of vents. In this case, the air cannot fully escape from the die, and some entrapped air is predicted. Figure 1b shows the predicted amount of shrinkage porosity, which is another type of defect playing a crucial role in the variability of mechanical properties. The predicted shrinkage porosity shows a good agreement with the experimental data.

A simulation approach has been developed to get insight into the melt flow, solidification and defect formation during high pressure die casting of aluminium alloys. The predicted values of shrinkage porosity correlated with the measurements. Further comparisons are needed before simulation can be fully deployed to address variability of mechanical properties.