High aspect ratio micro moulding for application in dental surgery

Author: Paul Glendenning, Micro Systems (UK) Ltd, Warrington, UK

A new type of dental surgery device has been developed for root canal treatment. One of the key challenges in taking the concept to reality was that of finding a mass production method to make a high aspect ratio x-ray opaque core with a tip diameter of less than 0.2mm. The solution to this has been found through innovative tooling design and micro-moulding.

The device is used to fill the cavity created when the root and nerve of a tooth are removed, typically because of infection caused by decay or injury. Traditionally, a thin plug and sealant are inserted after cleaning, but this procedure can leave voids in the canal and result in subsequent infection that requires the procedure to be repeated. The radio-opaque core of the “smartpoint” device is coated with a hydrophilic polymer coating, which expands laterally as it absorbs water from the tooth; this creates a tight seal that prevents re-infection.

Figure 1 illustrates in a diagram, the way in which the Smartpoint core is used placed into the tooth. Figure 2 shows the filled root canal.

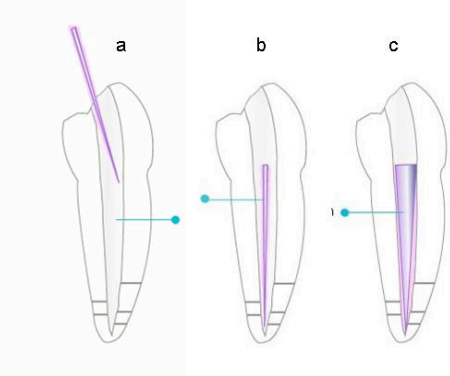

Fig 1: ‘smartpoint’ in root canal of tooth.
(a)Prepared canal, (b) core covered in paste,
(c) lateral expansion of core.
(www.smart-seal.co.uk)

Fig 2: X-ray showing sealed root canal of tooth.

Moulding of thin, high aspect ratio structures is very challenging and will normally require high-flow polymer material grades. However, to fulfil the specific requirements of this application, the component has to be moulded in a hygroscopic polymer filled to 60% by weight with radio-opaque filler. The weight of the component (figure 3) is 0.06g, and the 43mm long part has a tip diameter of 0.18mm.

Whereas with some conventional polymers, it is relatively easy to fill the full length of the cavities, using a very highly filled material the process becomes much more demanding. In this application, the situation is further compounded by the unique material which has to be very closely controlled in terms of pre-processing as well as moulding. Precise humidity control is needed to allow reliable micro-moulding of the polymer.

The two cavity production mould for this component is of a three-plate design whereby the part can be directly injected on the axis at one end (Figure 4). The cavity form is constructed from a two piece “clam-shell” with the two halves precisely aligned to avoid any mismatch, including at the 0.18mm diameter tip. The cavity form

was produced in hardened steel by high speed micro-milling. On mould opening, the runner and gates are automatically separated from the two moulded components, and the mouldings are removed from the mould by a robot on the machine, to be inspected by a vision system.

Two moving halves of the mould are used which rotate on a turntable on the machine. This allows one pair of cavities to be injected whilst another pair is simultaneously removed from the mould for downstream handling. Vacuum and air-blast functions are built into the mould for more effective and reliable operation.

The “smartpoint” device was conceived by DRFP Ltd (Sheffield, UK). The solution was developed in collaboration with Micro Systems (UK) Ltd, based near Manchester, UK, and the Micro & Nano Moulding Centre, University of Bradford, UK. The device won a prestigious Plastics Industry Award in the UK for best technology application.

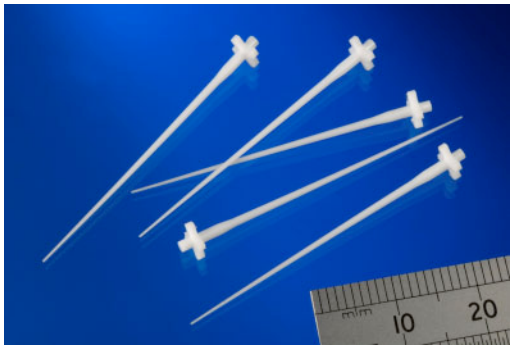

Fig 3: Smart point cores

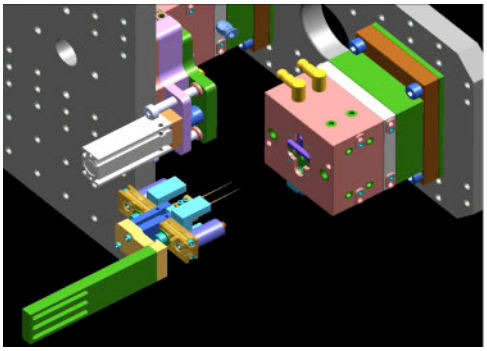

Fig 4: View of the mould design showing robot head (bottom left) removing two of the moulded ‘smartpoint’ cores.

Article Published in German Language: *IVAM Inno, Nr. 44, P 10, Oct 2009, German Magazine*