

## **Flow behavior characteristic for injection process using nano-yttria stabilized zirconia for micro metal injection molding ( $\mu$ MIM)**

### **Abstract**

Micro metal injection molding ( $\mu$ MIM) prior to conventional plastic injection molding (PIM) has become widely demanding due to its smaller size, more complex geometric surface and time consuming on its product. Metal and ceramic in powder form of various sizes up to  $\mu$ m is mixed with binder system to produce products that meet the requirements. Nano size yttria stabilized zirconia (YSZ) with average particle size of 25nm, was tested both physically and mechanically for its properties before mixing and injection process using several testing such as Scanning Electron Microscopy (SEM), Energy Dispersive X-ray (EDX), pycnometer density, critical powder volume percentage (CPVP) and rheology respectively. Grain shape for YSZ particle is near spherical with the diameter range between 21.2 - 33.5nm while the CPVP shows the highest powder loading was 41.4%. Binder system of 70% palm stearin and 30% polypropylene (PP) was then mixed with YSZ at 37%, 38% and 39% by using internal mixer with roller blade type. By using CPVP of 41.4% as the guideline, mixing was done beyond the critical point until it is capable of becoming the dough mixture and was found that 43% powder loading is the highest loading it can achieved. This dough form of every mixture of powder loading was crushed to obtain pellet size as the feedstock. Rheology test was carried out for each powder loading at 180°C, 190°C and 200°C with the load increasing from 10N to 20N to determine the plastic behavior and best relationship between viscosity (Pa.s) and shear rate (1/s). Dilatant flow behavior for all the powder loadings and smooth data distribution during testing at 180°C was observed respectively. Critical parameters involving in injection process such as mold temperature (°C), melt temperature (°C), pressure (bar) and time (s) was manipulated for every powder loading to obtain the best result with no defects such as shot and flashing. Each critical parameter increased gradually as the powder loading (%) increased. Debinding and sintering process will be carried out to determine the strength and toughness by using micro hardness and micro tensile test respectively.