Tools&Components

Sensor-actor coating – Enabler for controlled production processes

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Temperature control in aluminum die casting is crucial for sustainable processes, influence on solidification behavior and high product quality. To enable temperature control, knowledge of the temperature in the loaded contact zone is required during production process. Therefore, a multilayer sensor coating consisting of an insulation layer towards the tool, two functional sensor layers consisting of Ni and NiCr and a top insulation layer is applied by means of physical vapor deposition (PVD). Temperature sensor function bases on the thermoelectric effect. In addition to the sensor function, the coating needs to be wear resistant in order to protect the sensor function and the mold. The resistance of the sensor coating in contact with molten aluminum was analyzed in rotating immersion tests. The rotating immersion tests were carried out three times for a period of two hours. The temperature was measured during heating, rotation in molten aluminum and cooling. In addition to isolated temperature measurement, the PVD sensor coating can be combined with a thermally sprayed (TS) actor coating for heat application to a multilayer sensor-actor coating. Therefore, an actor coating is positioned underneath the PVD sensor. For heat generation, the function of a resistance heater is integrated into the TS actor coating. To investigate the sensor-actor function, the multilayer coating was exposed to thermal cycling tests. In contact with molten aluminum, the PVD sensor coating showed minor adhesion to aluminum melt. High resistance to cohesive or adhesive failure was found. The combination of PVD sensor coating and thermal sprayed heater coating was successfully applied. The TS actor coating tempered the surface in the temperature range from T = 80 °C to T = 200 °C with high dynamics. At the same time, the PVD sensor coating measured the temperature at the surface with short response time to heating cycles of the actor coating. In thermal cycling tests, the sensor function showed a comparable temperature profile to reference measurements with an infrared sensor. Due to a smaller sensing area, the sensor coating reflected local temperature fluctuations more clearly. By means of the sensor-actor coating, temperature can be measured at contact surface and heat can be applied if necessary. The high measurement and heating dynamics can be used for controlled solidification and lead to improvement of product quality and reduction of deviating products. The multilayer sensor-actor coating offers the opportunity to control temperature in primary and forming processes, for machine elements or for processing temperature-sensitive materials, such as polymers in injection molding. In further steps, reduction of the energy demand could be realized due to local heat control.