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Abstract

Dual Function WS_2 Thin-Films as a Substrate for Ultrafast Response Thermocouple to Temperature Evaluation in µinjection Molding †

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Nowadays, mold and plastics companies are aware of markets' increasing globalization, which leads to enhanced competition in the industrial environment. This requires the best conditions of productive flexibility to overcome the challenges. An example is the microfabrication process, initially applied in integrated circuits in the production of up to several small-scale components today [1]. Injection molding microfabrication allows the production of parts/systems/devices or their features, where the scale is sub-millimeter, based on polymeric materials, at high series and complex geometries in relatively short periods. However, this technology involves a rigorous control process to ensure the quality of the injected microcomponents. Therefore, the injected material must be distributed evenly inside the µmold to minimize the occurrence of defects during the process, which is dependent on the injection pressure during the process and the mixture viscosity. Since viscosity is related directly to the temperature inside the mold, an ultra-fast response of temperature sensors is necessary. This requirement requires thin-film thermocouples to be deposited on the critical zones of the mold (i.e., inserts). However, the µmold must have a coating to achieve two purposes: improve the lifetime of the mold and contribute to the part/system/device extraction. A WS_2-based coating with the addition of C (W-S-C) was demonstrated to be the solution concerning high hardness and very low friction coefficient. However, the carbon presence excludes the possibility of this coating being used as a substrate to deposit an ultra-fast thermocouple (T-type). The present study shows that another type of WS_2 (W-S-N) film has a lower electrical conductivity than the other kinds of WS_2 coatings and maintains the characteristics of mold surface coatings. The W-S-N film also allows for temperature evaluations with precision and ultra-fast responses (microseconds). Studies about the optimization of thermocouple thickness have shown that 300 nm induced a superior signal sensitivity.

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