V_2O_5 thin film for high sensitivity flexible and transparent thermal sensors

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Abstract

Transparent and flexible temperature sensors are key elements for a wide range of applications. This work reports the Seebeck coefficient optimization of V_2O_5 to achieve high temperature sensitivity keeping the transmittance in the visible range above 60% in flexible polyamide substrates. Film thickness has a major role on the Seebeck coefficient, the maximum S of 630μV/ºC was obtained for a 75nm thick film annealed at 573K during 3h.
Thermal detection methods are needed in microfluidic systems to detect temperature changes caused by endothermic or exothermic reactions. The traditional macro temperatures sensors are unsuitable for detecting the temperature change in microchannels or microvolume reagents. Benyamin Davaji and Chung Hoon Lee recently proposed a paper-based calorimetric detection [1]. Micro-scale gradient sensor to measure the heat flux through a surface has been proposed by B. A. Jasperson et al. [2] based on Cu substrates, Cr, Ni and polyimide. I.F. Yu et al. [3] prepared micro heater and micro-thermal sensor for heating and temperature control of a microfluidic chip to rapid diagnosis of cancer mestastatic. A side wall thermoucouple was produced inside and on top surface of microfluidic channel, Takahiho Yamagushi et al. [4] being claimed as main advantage of this thermoucouple the possibility to measure the temperature of the flow in microchannels while its visualization on microscope is allowed.
Most of the thermal sensors for microfluidic applications have in common the need of several microfabrication processing and each sensor is utilized only for the corresponding chip.
The sensitivity is the crucial parameter for a thermoelectric temperature sensor (TTS). The simpler and direct way to create a sensor device with high sensitivity (excellent performance as sensor) is to prepare a material with high Seebeck coefficient. A common TTS is the thermocouple. A thermocouple is a junction formed from two dissimilar metals. One is the reference temperature and the other is the temperature to be measured. A temperature difference will cause a voltage to be developed that is temperature dependent based on Seebeck effect.
The sensor studied in this work has same operating principle, but a great advantage, uses harmless and nature abundant materials, with the novelty of being transparent and flexible-transparent thermoelectric temperature sensor (T3S). This sensor will cover a wide range of applications such as a simple transparent thermometer that can be placed on the top of the fluid channels in micro-fluidic chips, or any other surface that needs a transparent thermometer, as well as other possible skin sensitive applications.

References

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Figures

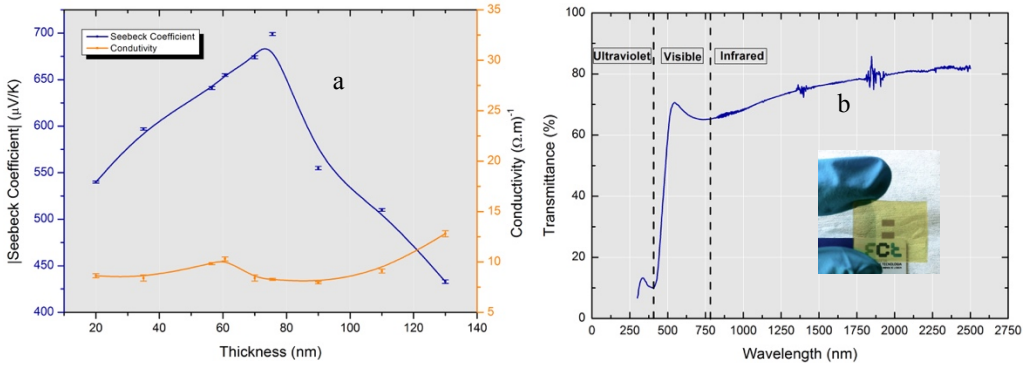

Figure 1 - Seebeck Coefficient and conductivity as a function of V_2O_5 thickness (a) and transmittance spectra for a V_2O_5 sample on corning glass (b).