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Author: Mrs. Christine Hill
University of Stuttgart, Germany

Prof. Stefanos Fasoulas
University of Stuttgart, Germany

INKJET PRINTING TECHNOLOGY FOR NEW SPACE SENSORICS DEVELOPMENTS AND OPTIMIZATION

Abstract

For the first time, a complete solid state electrolyte oxygen sensor (SSEOS) has been produced using Inkjet technology. This allows unprecedented flexibility in sensor design as well as optimization for new space applications. For several decades solid state electrolyte sensors are established systems for the detection of gases under extreme conditions, such as high temperatures, corrosive media or transient processes. One representative is a SSEOS whose electrolyte consists of yttria stabilized zirconia (YSZ). Additionally increasing miniaturization becomes more important to minimize the power requirements of the sensors and to reduce the response time and the consumption of expensive materials. The manufacturing process today is based on screen printing (SP) technology, building up a sensor by printing each layer successively. However, this technology has strong limitations in flexibility of the layout and re-designs and therefore is suitable for mass production. Moreover a disadvantage is the high material consumption, especially in combination with the need of expensive noble metal and ceramic pastes, which leads to a high sensor unit price. Finally using SP technology the miniaturization of the sensors is limited. The Inkjet technology opens up new possibilities in terms of dimensions, geometries, structures, morphologies and materials of sensors. This new approach is capable of printing finer high-resolution layers without the necessity of meshes or masks for patterning. Using the Inkjet technology a design change is possible at any time. Moreover the ink is only deposited where it is needed. Custom made sensors are thus realized simply, economically and ecologically. Finally another expected advantage of increasing the gas detection range by an increased three phase boundary arises when using Inkjet technology. Based on the knowledge of the SP sensor production series of miniaturized solid SSEOS was manufactured at the Institute of Space Systems completely by Inkjet technology for the first time. For this purpose all layers, including the functional ceramic up to platinum electrodes were printed with the DMP-2831 printing system and sintered according to the material properties. First measurements in vacuum environment showed clear signal response to changing oxygen concentrations. The obtained results demonstrate the potential to use the technology development in space applications such as in-situ oxygen measurements in the surroundings of the International Space Station ISS. Further approaches, regarding the proof of an increasing oxygen detection range could furthermore lead to additional approaches such as in-situ respiratory gas analysis systems or redundant safety sensors for life support test beds.