



## Abstract Materials-Related Challenges for Autonomous Sensor Nodes <sup>+</sup>

## Marco Deluca \* and Anton Köck

Materials Center Leoben Forschung GmbH, Roseggerstraße 12, A-8700 Leoben, Austria; anton.koeck@mcl.at \* Correspondence: marco.deluca@mcl.at

+ Presented at the 6th International Electronic Conference on Sensors and Applications, 15–30 November 2019; Available online: https://ecsa-6.sciforum.net/.

Published: 14 November 2019

**Abstract:** The current technological trends associated with Industry 4.0 and the Internet of Things (IoT) require an interconnected network of sensor nodes providing distributed information on the environment in order to enable intelligent action to be taken by control systems. Typical examples are the condition monitoring of machines or industrial equipment, or the detection of hazardous environmental conditions (e.g., in chemical plants). Such sensors need to be distributed in areas that are difficult to reach for wiring or to exchange batteries, and thus need to be self-powered and energy-independent. In this work, we provide an overview of possible strategies to realise a positive energy balance in autonomous sensor nodes without the use of batteries, focussing on gas sensors for air-quality monitoring as a use case. We will first present ways to reduce the power budget of sensing elements using self-heating nanowires made of CMOS-compatible metal oxides. We will then concentrate on energy harvesting and storage, showing state-of-the-art possibilities in both cases: broadband piezoelectric harvesters, perovskite-based photovoltaic elements, and high-energy density ceramic capacitors. Finally, we will discuss the possibility of integrating all sensor node elements in a single device using advanced interconnect technologies.

**Keywords:** autonomous sensors; internet of things; gas sensors; energy harvesting; energy storage; dielectric capacitors



© 2019 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).