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for a temperature sensor (or other sensor types). The sensor has been tested in a EUROCOPTER helicopter, Jirků T., Fiala P. and Kluge M., 2010.

8763-82, Poster Session Thursday

Biomimetic MEMS sensor array for navigation and water detection

Oliver Futterknecht, Technische Univ. Wien (Austria); Mark O. Macqueen, Aramis Technologies (Malaysia); Salmah B. Karman, Univ. Kebangsaan Malaysia (Malaysia) and Univ. of Malaya (Malaysia); S. Zaleha B. M. Diah, Univ. Kebangsaan Malaysia (Malaysia); Ille C. Gebeshuber, Univ. Kebangsaan Malaysia (Malaysia) and Technische Univ. Wien (Austria) and Aramis Technologies (Malaysia)

The focus of this study is biomimetic concept development for a MEMS sensor array for navigation and water detection. The MEMS sensor array is inspired by abstractions of the respective biological functions: polarized skylight-based navigation sensors in honeybees (Apis mellifera) and the ability of African elephants (Loxodonta africana) to detect water. The focus lies on how to navigate to and how to detect water sources in desert-like or remote areas. The goal is to develop a sensor that can provide both, navigation clues and help in detecting nearby water sources. We basically use the information provided by the natural polarization pattern produced by the sunbeams scattered within the atmosphere combined with the capability of the honeybee's compound eye to extrapolate the navigation information. The detection device uses light beam reactive MEMS, which are capable to detect the skylight polarization based on the Rayleigh sky model. The actual challenge is to reduce the interference within the bandwidth of the visible light; therefore the focus lies on the UV part of the spectrum.

For water detection we present various possible approaches to realize the sensor. In the first approach, polarization is used: moisture saturated areas near ground have a small but distinctively different effect on scattering and polarizing light than less moist ones. Modified skylight polarization sensors (Karman, Diah and Gebeshuber, 2012) are used to visualize this small change in scattering. Application of this technique near ground indicates water sources near the ground surface. The second approach is inspired by the ability of elephants to detect infrasound produced by underground water reservoirs, and shall be used to determine the location of underground rivers and visualize their exact routes.

Reference:

Karman S.B., Diah S.Z.M. and Gebeshuber I.C. (2012) “Bio-inspired polarized skylight-based navigation sensors: A review”, Sensors 12(11), 14232-14261.

8763-83, Poster Session Thursday

Simulation and design optimization of transparent heaters for spectroscopic micro cells

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In several fields of miniaturized analytical systems micro cells or chambers are used. For example for spectroscopic applications like the central cell for chip scale atomic clocks [1] a dedicated temperature of the inner cell surfaces is needed. The minimal temperature is important for the behaviour of the principal function and the homogeneity within the cell influences the overall power consumption. Therefore an optimized transparent heater structure is necessary to heat the cell with a minimum amount of energy to a specific lower temperature limit. Transparent heaters have the capability to be used on optical windows. Heating directly on the optical windows is necessary to avoid the condensation of alkali atoms on the optical ports. In this work indium-tin- oxide (ITO) as a transparent conductive thin film is used. Different heating approaches are simulated by finite element analysis in COMSOL Multiphysics. First the modelling concept is proved by investigations on simple heating bars. Proved by good agreement with real existing heating bars we investigated several structures which promise to provide more uniform temperature profiles.

First results show that meander based structures provide temperature distribution with slightly higher temperature values in the middle of the heated area. Detailed analysis discovers a heat accumulation with a maximum effect in the middle of the structure. This becomes a dominant effect due to the low temperature conductivity of the substrate. To compensate this phenomenon we modified the width of the wire at a given thickness by a length dependent formula as introduced by [2]. This leads to a wire shape like a muscle which results in a variation of the current density and hence the heat generation is adapted. Thus the heat distribution becomes more uniform. The combined result of an optimised arrangement and wire shape shows the best homogeneity of the temperature profile.

[1] S. Knappe et al., „MEMS Atomic Clocks“, in „Comprehensive Microsystems“, ISBN 978-0444521941, vol. 3, pp 572, 2008.

[2] N. Mahnke et al., „Numerically optimized shape of directly heated electrodes for minimal temperature gradients“, Sensors and Actuators B, 137, p. 363–369, 2009.

8763-84, Poster Session Thursday

Flip chip packaging of piezoresistive barometric pressure sensors

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Piezoresistive pressure sensors are used in many applications e.g. automotive, medicine and consumer electronics. Barometric pressure sensors are now widely used in navigation systems and mobile phones. For these devices the size of the pressure sensors must be further decreased. It is also important that the sensor chips are packaged with ultra-low stress. Up to now most pressure sensor chips for barometric pressure have been packaged using a soft adhesive and wire bonding. However, it is difficult to achieve a very small package size and height with wire-bonding type packages. For other electronic components flip-chip packaging is used for highly miniaturized packaging. However, standard flip chip packaging is not suited for piezoresistive pressure sensors because of the rather high stress induced on the sensor chip by the package. So we have developed a low stress flip-chip package with springs between the sensor chip and a ceramic cavity housing. The under bump metallization (UBM) on the sensor chip side was optimized to further decrease the packaging stress.

In a standard flip chip package the different coefficients of thermal expansion (CTE) of chip and substrate and strong mechanical coupling by the solder bumps would lead to stress in the sensor chip which is not acceptable for piezoresistive pressure sensors. To overcome this problem we have developed a new ultra low stress flip-chip packaging technology. In this technology first an UBM is patterned on the sensor wafer. As the next step solder bumps are deposited. After wafer-dicing the chips are flip-chip bonded on springs within a ceramic cavity.

As a source of residual stress we identified the UBM and the solder bump on the sensor chip. Different CTEs of the silicon chip and the UBM/solder lead to creep strain in the aluminum metallization between UBM and chip. As a consequence a temperature hysteresis can be measured which is shown in Figure 1 (see upload).

As can be seen the actual measurement at a certain temperature depends on the previous temperature conditions. Here the external pressure is 1000 hPa.

In this contribution we will explain how the temperature hysteresis of about 2 hPa could be reduced by modifying the chip layout. Changes are the thickness of the chip, the depth of the cavity or smaller