Annular microelectromechanical angular rate sensor

The present invention relates to annular microelectromechanical angular rate sensors.

Annular microelectromechanical angular rate sensors operate according to the principle that a self-contained structure, which is typically designed as a circle or ring, is made to oscillate above a substrate parallel to the substrate plane. If the ring is rotated about an axis of rotation perpendicular to the substrate plane, the oscillation movement of the ring generates a Coriolis force on the individual mass points of the ring. This leads to the superimposition of a further oscillation, the amplitude of which depends on the angular rate of the rotation. As the oscillation direction of this detection oscillation is, in principle, predetermined by the position of the ring and the excitation oscillation, and the parameters of the excitation oscillation are also known, the detection oscillation can be read out in order to determine the angular rate.

In practice, plate electrodes placed along the circumference of the ring are often used to excite and read out the oscillations. However, this takes up a lot of space and does not meet all requirements for the angular rate sensor. Such plate electrodes can also be used to compensate for so-called quadrature errors, which often affect microelectromechanical sensors due to inevitably arising manufacturing tolerances.

However, the problem here is that electrode plates placed on the outside along the circumference of the ring are limited in terms of the electrode area. As a larger signal can be fed in or read out via a larger electrode area, the use of external electrode plates is disadvantageous. It is also not always possible to design the excitation and readout electrodes optimally with external electrode plates.

Embodiments of the present invention disclose an annular microelectromechanical angular rate sensors with a large electrode area, which have a compact design and allow compensation for quadrature errors without restricting the possibility of exciting the ring of the angular rate sensor or reading out oscillations.

According to an aspect of the present invention, there is provided a microelectromechanical angular rate sensor has a flexible ring structure, which forms a circle at rest and which is suitable for producing an excitation oscillation substantially parallel to the plane of the circle above a substrate, said excitation oscillation being superimposed with a detection oscillation generated by the Coriolis force during a rotation of the ring structure. Moreover, the angular rate sensor has at least one coupling structure, which is connected to the ring structure and is designed in such a way that it is, together with electrodes which are fixed to the substrate, suitable for compensating for a quadrature error of the angular rate sensor.

There is therefore no longer an attempt to compensate for quadrature errors via plate electrodes or similar, which act directly on the ring structure of the angular rate sensor. Instead, a coupling structure is connected to the ring structure to which compensation forces can be applied. The coupling structure then passes these compensation forces on to the ring structure and can thus compensate for quadrature errors. The specific design of the coupling structure is arbitrary, as long as the movements of the coupling structure caused by the compensation forces are transferred to the ring structure to a sufficient extent in order to be able to bring about a controllable and measurable influence on the movements of the ring structure through the strength of the compensation forces. Due to the small oscillation amplitudes that usually occur in microelectromechanical devices, it is typically sufficient for compensation to take place in a first approximation.

Moreover, the use of the coupling structure allows a freer placement and design of electrodes, which can provide an overall larger electrode area and enable an advantageous design of electrodes with different functions, such as excitation and readout electrodes.

In particular, the use of the coupling structure, especially when the spring stiffnesses of the various components of the angular rate sensor are designed appropriately, makes it possible to achieve that the size of the amplitude of the oscillations produced by the ring structure is greater than the size of the oscillation amplitudes of