9th International Workshop on Electrodeposited Nanostructures

Electrodeposition of nanowire arrays for accelerometers and their mechanical properties

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Many cell phones and navigation devices are typically equipped with commercial, capacitively working accelerometers that use a movable bulk material as functional sensor element. Our approach aims at replacing the bulk material by a flexible nanowire array which could notably improve the properties of the sensor due to its smaller size and thus increased sensitivity and faster reaction time. The sensor response is based on a change in capacitance that is generated by a deflection of the array relative to a stationary electrode [1]. The flexibility of the nanowire array plays a key role for the expected high quality of the sensor.

Here, we present a method for fabricating a sensitive accelerometer that is based on the integration of a well-defined microscopic nanowire array with a seismic mass on its top as functional sensor element into a microchip. The integration is performed via a growth-in-place method using photolithographically structured polymer track-etch templates. Templates produced by ion track technology provide the great advantage of adapting the properties of the nanowire arrays in terms of length, diameter and number of the wires, as well as the array diameter and the size of the seismic mass. Homogenous nanowire growth was achieved by a pulsed electrodeposition. The formation of the seismic mass is performed by extending the deposition process after the track-etched channels in the template are completely filled and caps are grown. Cap coalescence and final thickness of the seismic mass is controlled by the duration of the galvanic process.

We also show first results on the mechanical characterization of the nanowire arrays performed by applying a horizontal force to the top layer of the array and measuring the resulting displacement (Figure 1).

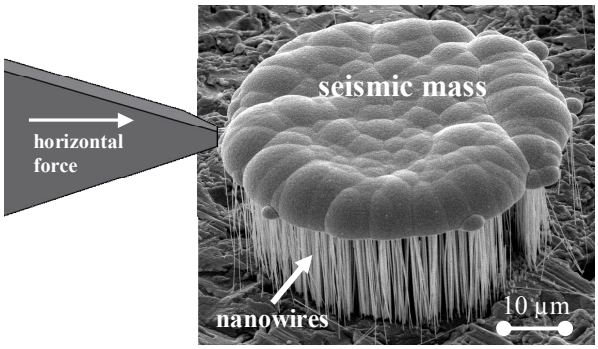

Figure 1a: Scanning electron microscopy-image of nanowire array with coalesced caps as seismic mass before an external, horizontal force is applied

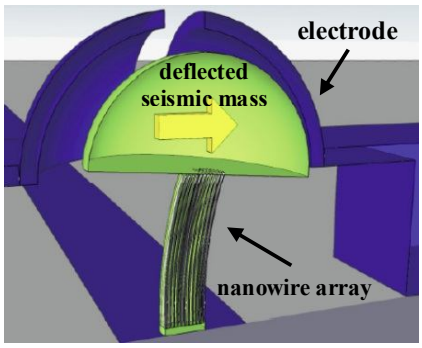

Figure 1b: Scheme of accelerometer with seismic mass on top of flexible nanowire array. Bending, due to acceleration produces signal in top electrode [2]

So far, mechanical properties have only been investigated for single nanowires [3, 4], but nothing is known about nanowire arrays. For first mechanical measurements, arrays of different wire radius, number of wires and lateral array dimensions were produced. Measured force-displacement-diagrams prove that the nanowire arrays are remarkably flexible. The experimental results are in good agreement with calculated values.

Our results give new insight in the behavior of nanowire assemblies and will help to design optimized structures for advanced accelerometers.

References:

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