Use of nanocrystalline nickel microforce sensors in practice

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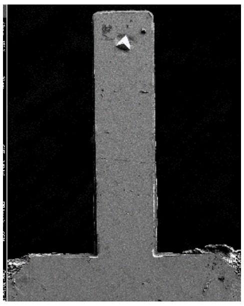
ABSTRACT

Silicon-based electromechanical microelectromechanical devices (MEMS) play a key role in detecting accelerations and forces below 1mN, with a resolution suited to detecting accelerations of 1mG (G - ground acceleration) and forces of 1μN for commercial applications. However, their limited accuracy and precision do not meet the requirements of professional applications such as aerospace or nanotechnology. In response to these challenges, our laboratory has initiated work on a new generation of MEMS using metal instead of silicon, a key innovation. Through the use of photolithography, galvanic deposition and selective etching, it is possible to create devices from metal springs with a lower Young's modulus and inertial elements from materials with a higher density than silicon, such as gold. This approach not only increases the sensitivity of accelerometers, but will also make them more resistant to shock loads and usage errors, opening up new possibilities for advanced professional applications.



Our approach, which can be considered a modern form of miniature electroforming, uses the flexibility of the metal substrate to form a variety of shapes, which was initially used to create simple structures, such as beams or columns, for the study of scale effects.

Recently, our technology has found its way into the production of advanced measurement probes for atomic force microscopes, paving the way for the development of more complex MEMS devices. The ability to use different metals, such as tin for springs and nickel or gold for inertial components, significantly increases measurement accuracy, improves the signal-to-noise ratio and extends the measurement range of the devices.

A key aspect of our research is also the use of the developed sensors in the lateral force calibrators of atomic force microscopes, a significant innovation compared to the expensive and fragile silicon sensors used to date. Our solutions not only improve the accuracy and reliability of measurements, but also offer greater robustness against damage, which is crucial in many advanced scientific and industrial applications

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