Amorphous WN_x Metal the Best candidate for Accelerometers and Gyroscope

Abdulilah Mayet,
King Khalid University, Abha. Saudi Arabia
amayet@kku.edu.sa

Nanoelectromecahnical (NEM) switches and devices are getting more attention for their higher resonant frequency f_o and lower threshold voltage, thanks to their nano scale size. These two unique characteristics give NEM switches the preference and vantage against classical CMOS transistors in addition to lower leakage current and subthreshold swing slope. However issues such as stiction, line edge roughness, nano fabrication difficulties and material fractures and fatigue limit out the material selection for NEMS device fabrication. In this work, a novel material (amorphous tungsten nitride aWN_x) has been demonstrated that overcome most of the issues mentioned earlier. Amorphous WN_x demonstrates many interesting characteristics such as the follow: high Young's modulus (E = 300 GPa) which lead to a higher spring constant k_s, a high conductivity (R = 0.2 mΩ.cm) yielding a high resonance frequency, and Slight tensile stress (σ = —500 MPa) preventing curving downward nor curling upward. NEMS WN_x is deposited using a simple commercial PVD sputtering tool with commercial tungsten target and N_2 gas flow. All the fabrication process steps are CMOS compatible, no need for special tools neither special condition. Laterally moving cantilever device could be fabricated using a single mask, or three masks for vertically moving device, unlike 8 masks for PolyMUMPs devices. This could save more than 60% of the fabrication cost. Finally, the fabricated devices have high *Q* because of the high resonant frequency and small damping factor, $Q \approx \frac{\omega_o}{2\delta}$. as well as high sensitivity, which is expressed as $\frac{\Delta f}{\Delta m} = \frac{f_o}{2\rho_c t}$, where ρ_c is density, *t* is the thickness and f_o is the resonant frequency. The high density (ρ = 19 g.cm^{-3}) which makes it the best candidate for accelerometer and gyroscope mass proof. Using WN_x to fabricate accelerometers and gyroscope, gives the advantage of single mask easy process and fast response time. The high density of WN_x leads to higher sensitivity device. Higher elasticity modulus leads to stiffer spring and longer lifetime in term of stiction, the most killing factor for NEMS and MEMS. The high conductivity leads to faster response in charging and discharging the sensing capacitance, which lead to a better operation than the existing classical devices.

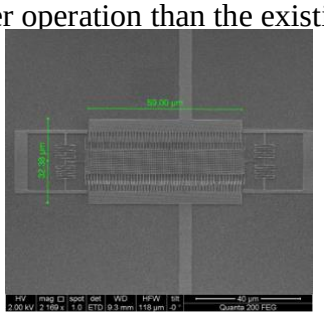

Figure 1: SEM picture of fabricated Accelerometer using e-beam lithography