MEMS Gyroscopes Continued from ELEC 5760/6760

→ Refer to Fall 2014 Solid State Sensors Course

→ lectures 11/10/14 – 11/17/14

1. Dynamic equations of motion for a MEMS vibratory gyro

→ refer to gyro drawing on next page

① $m(\ddot{x} - \alpha y - 2\Omega\dot{y} - \Omega^2 x) + c_x\dot{x} + k_x x = A_x \sin(\omega_d t)$

② $m(\ddot{y} + \alpha x + 2\Omega\dot{x} - \Omega^2 y) + c_y\dot{y} + k_y y = 0$

after simplifications:

① $m\ddot{x} + c\dot{x} + kx = A_x \sin(\omega_d t)$

② $m\ddot{y} + c\dot{y} + ky + 2m\Omega\dot{x} = 0$

$2m\Omega\dot{x}$ → Coriolis acceleration term ($2\Omega\dot{x}$)

→ note: this assumes $\omega_s = \omega_d$ ($\omega_y = \omega_x$). Usually $\omega_s > \omega_d$ → more on this later

2. For the example MEMS gyro in 5760/6760:

$$V_{out} = \frac{4nmA_x \varepsilon_0 \varepsilon_r + V_b V_x R_b}{c^2 X_0}\Omega = K\Omega$$

note: m, t, c, X_0 vary with fabrication tolerances

V_b, V_x can be noisy

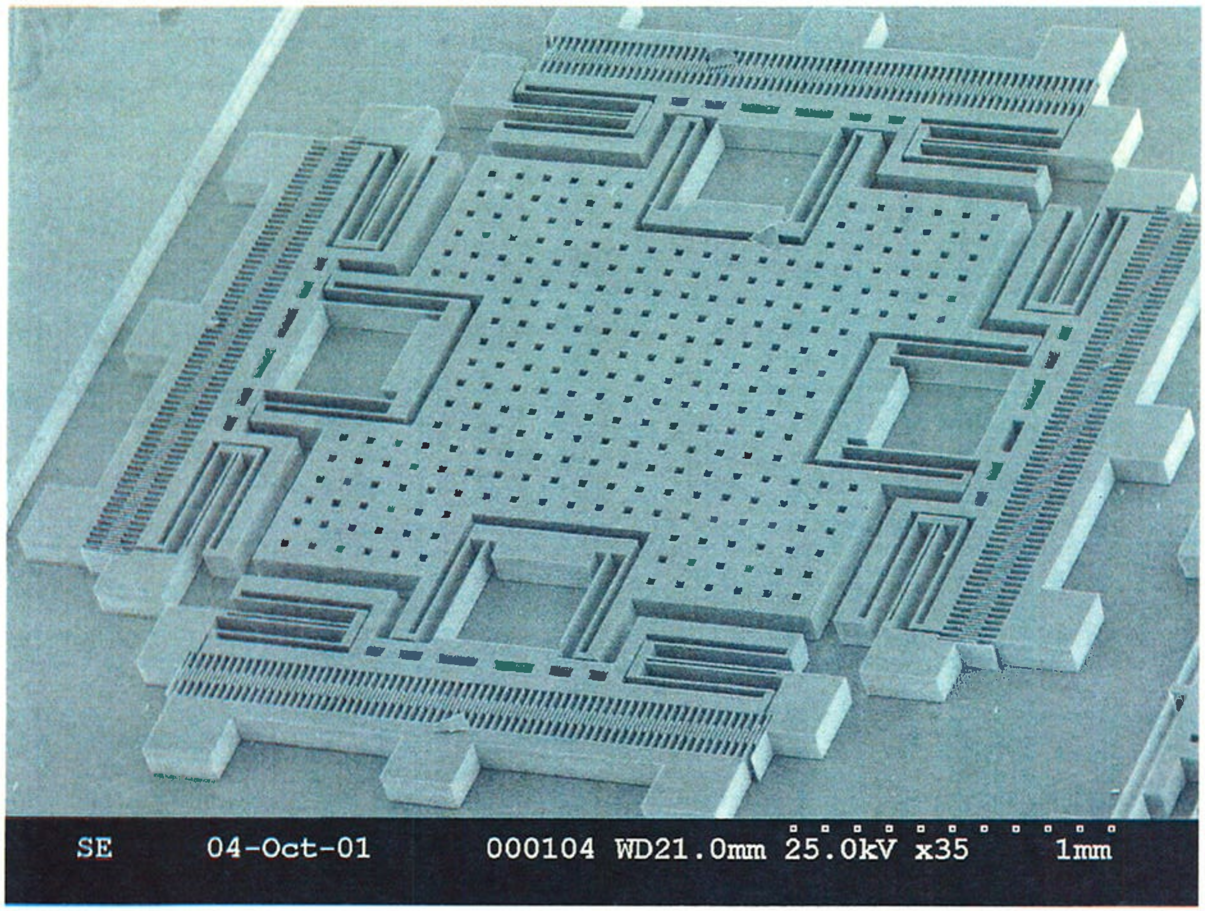
c, R_b can change with temperature, aging

R_b can vary based on tolerance

c, R_b have associated thermal noise

⇒ all affect the accuracy of K and therefore V_{out}

Photograph of a MEMS Gyroscope



SOI fabrication process

Photo courtesy of Morgan Research Corporation