Imaging MEMS motion at nano scale by time-resolved scanning electron microscopy

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Design and fabrication of micro-electro-mechanical-systems (MEMS)would greatly benefit from a local and direct measurement of their in-operando dynamics on a point-by-point basis with sub-micron resolution. We introduce and discuss the implementation of dynamical imaging of MEMS by time-resolved scanning electron microscopy (TR-SEM). MEMS resonators are actuated in-operando close to their resonance frequencies, and a synchronized comb of electron pulses is used to image stroboscopically the device at a controlled time delay with respect to the beginning of its oscillation period.

We demonstrate the acquisition of stroboscopic movies by a proper sequential acquisition of secondary electron signal. Unprecedented information about local trajectory is provided, in the microsecond scale and at tens of nanometer lateral scale. In-operando nonlinearities in the response of the system, interpretable as related to system hardening are brought into evidence. We also discuss strategies to reach the ultrafast time scale*.

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