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Multifunctional self-sensing microcantilever arrays for detection of chemicals and explosives

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Micromachined cantilevers lend themselves well to numerous sensing applications wherein the presence of an analyte is manifested mechanically in cantilever deflection and/or a resonance frequency change. The sensitivity, compactness, cost, power-consumption, scalability, and versatility of microcantilever sensors will continue to drive their appeal in numerous applications. Most cantilever systems to date have been relegated to lab use because they are cumbersome and bulky, requiring extensive setup efforts, alignment and calibration. Commercially available cantilevers require external sensing with optical systems and external actuation. Piezoelectric sensing elements eliminate the need for external optics and external actuators; piezoelectric cantilevers have low power consumption in the sensing element due to their high impedance and low drive- voltage requirements. They have the inherent strength of self-sensing and integrated actuation, meaning that the actuation signal can also be monitored as a sensor signal, and each element can be actuated independently and directly. The self sensing method enables compact and scalable cantilever sensing applications that were previously unfeasible. We have recently demonstrated a novel piezoelectric microcantilever array platform, with and without selective coatings, for detection of various chemicals and explosives. We have also demonstrated the ability to heat the cantilever, and measure both heat and impedance changes in addition to mass loading and unloading. This multidimensional approach offers a unique advantage for chemical selectivity and will be compared with other cantilever and non-cantilever methods.