Adsorption/Desorption Characteristics of Explosive Vapors on Uncoated Silicon Microcantilever Surfaces

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Fast and sensitive detection of explosive vapors is important for number of applications ranging from passenger baggage-screening at airports to disarming of landmines. Such a sensor system based on silicon cantilevers would be additionally desirable due to its compactness and possible low cost. A detailed understanding of the adsorption/desorption characteristics of explosive vapors for silicon cantilevers is valuable for the design of microcantilever-based explosive vapor detection system. We conducted a series of measurements on adsorption/desorption of explosive vapors trinitrotoluene (TNT), pentaerythritol tetranitrate (PETN), and hexahydro-1,3,5-triazine (RDX) on piezoresistive silicon microcantilevers. The mass change of the microcantilever due to the adsorption or desorption of explosive molecules was deduced from the change in its resonance frequency. In the first series of measurements, we monitored the mass loading of a cantilever exposed to well–characterized explosive vapor streams. These measurements were used to estimate the sticking coefficients, which were found to be higher than 0.1. In another set of measurements, we monitored the mass unloading due to desorption of explosive molecules from the cantilever surfaces. Depending on the amount loaded on the cantilever, TNT desorption took a few minutes to tens of minutes (for nanogram quantities of TNT). On the other hand, desorption of PETN and RDX took many hours. There is a good correlation between the desorption time and the melting point of the particular substance.

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