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Explosive molecule detection by nanomechanical resonator and photothermal spectroscopy

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Nanomechanical resonators are good sensors because of their small mass, high frequency and high quality factor. In particular for mass sensing, the adsorbent mass is estimated from the shift in mechanical resonance frequency. Fantastic progress has been made in mass sensitivity, reaching the single protein and even yoctogram mass level. Yet this technique alone is not sufficient to identify the adsorbent molecule. We must add a second technique to our system to gain chemical specificity. Photothermal infrared (IR) spectroscopy, a technique based on IR absorption by resonant molecular vibrations, is straight forward, simple, and easy to couple to the system. The molecule absorbs light at the wavelength of its molecular vibration, producing heat, resulting in a shift of the resonance frequency of the resonator. Combining this IR absorption spectroscopy with nanostring mechanical resonators, we have detected femtogram levels of the explosive molecule 1,3,5-trinitroperhydro-1,3,5-triazine (RDX), representing the lowest RDX values ever measured by IR spectroscopy.

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