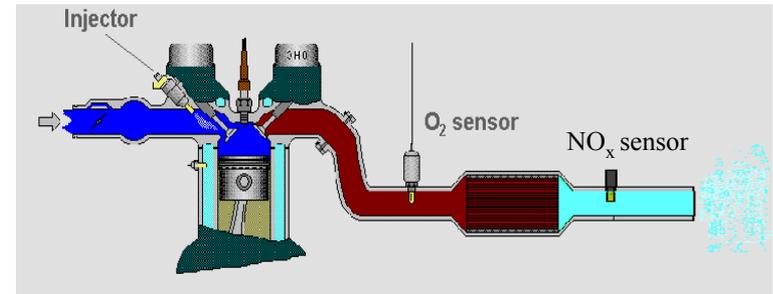


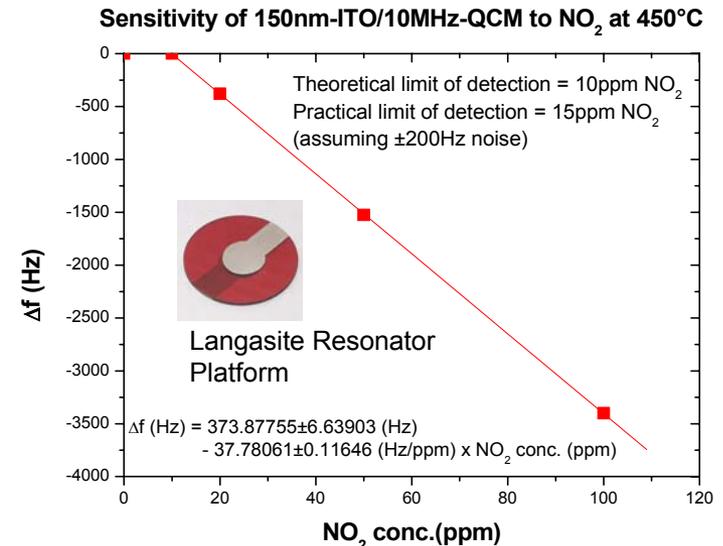
Resonant Gas Sensor for Exhaust Monitoring

Harry L. Tuller, MIT, DMR-0346434

- NO_x plays a central role in atmospheric reactions creating harmful ozone (smog) and acid rain. EPA has stipulated stringent emission levels requiring advanced engine management systems (EMS) relying critically on the availability of NO_x sensors providing precise and fast feedback to the EMS.
- Resonant-based acoustic devices, like those found in quartz watches, are highly sensitive to infinitesimal mass changes making them suitable as gas sensors when coated with selective films. We have successfully applied this concept to indium-tin oxide films on quartz crystal microbalances (QCM) with demonstrated sensitivity to NO_2 down to 20 parts per million (see figure).
- To survive harsh environments encountered in engine exhausts, alternatives to quartz must be found. We were the first to demonstrate that langasite, a novel piezoelectric material, could function as a nanobalance to 900°C and thus serve as the basis of a harsh environment resonator sensor platform. Research proceeds to understand the surprisingly strong sensitivity demonstrated by these devices and to isolate factors which potentially could serve to shorten their lifetime and to minimize cross sensitivities to thermal gradients, mechanical stresses and unwanted gases.



Auto exhaust system outfitted with sensors



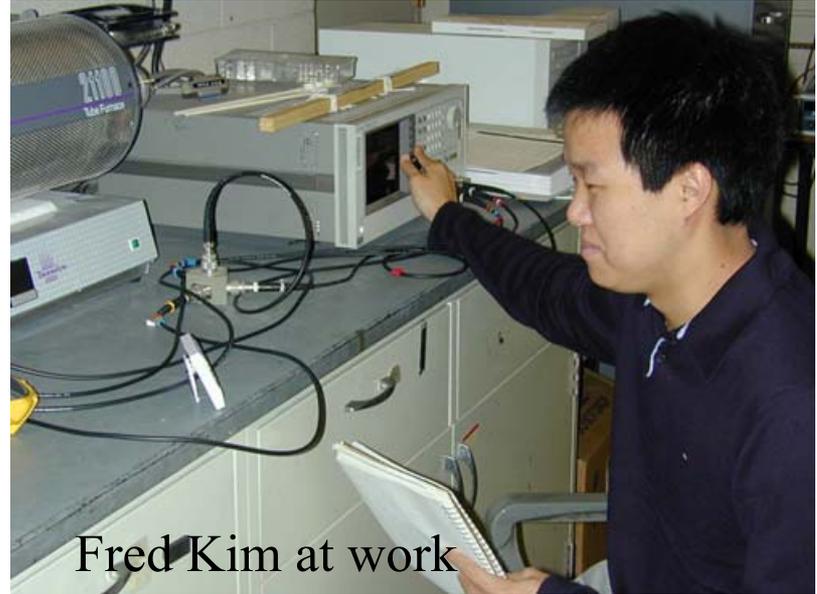
Resonator frequency shift with increasing NO_2

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Educational Outreach

- Fredrick Kim, an undergraduate at MIT, is working on this project as part of his undergraduate requirements, which will result in a senior thesis.
- Two doctoral students have been working on this project. Huankiat Seh, has worked closely in collaboration with German Colleagues on langasite at the University of Clausthal and visited their laboratory for a month. Todd Stefanik has collaborated and visited with colleagues in the University of Marseilles also for a month while working on gas sensitive materials. These collaborations have resulted in nearly a dozen joint publications. Both students have attended a number of national and international conferences
- Prof Tuller teaches an 'Electronic Materials Design' graduate level class at MIT, which draws heavily on elements of the groups research on sensors.



Fred Kim at work

- Prof Tuller participates in a summer MIT program in which approximately 100 high school science teachers attend and he lectures to them on advances related to environmental sensing and alternative energy sources.