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IR spectroscopy with pyrolytic carbon string resonator as a tool for particle detection

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Nowadays, nanomaterials are getting a lot of research attention all around the world, especially in nanomedicine. Therefore, novel tools for their characterization are needed. Recently, Infrared (IR) spectroscopy with Silicon Nitride (SiN) string resonators [1] and membranes have been used for fast analysis of minute sample amounts. Those resonators have been exposed to IR light from a quantum cascade laser (QCL) which resulted in a change of temperature along the resonator due to photothermal heating. The resulting frequency change can be tracked to obtain the absorption spectrum of the sample.

In this work, we also use the string resonator for IR spectroscopy. However, instead of the SiN, we fabricated strings from pyrolytic carbon. There are some advantages of using the pyrolytic carbon strings: (1) the fabrication process is simple [2], (2) pyrolytic carbon is more biocompatible and (3) the carbon structure can be tailored by modifying the pyrolysis parameters. The latter leads to a different IR absorption spectrum than for SiN which makes two type of strings complimentary. Figure 1a shows the SEM image of the pyrolytic carbon strings fabricated by pyrolysis of SU-8 photoresist. The strings have a length of 400μm with various width from 3μm to 30μm and a thickness of 750nm. The IR absorption spectrum of the pyrolytic carbon string is shown in Figure 1b. The results show that pyrolytic carbon string shows high absorption at higher wavenumber with an absorption peak at 1760cm-1. Compared to SiN strings the absorption in this range of 800cm-1 to 1600cm-2 is low, which should allow to detect nanoparticles absorbing in this range if they are deposited on the top surface of the pyrolytic carbon string. Finally, Figure 1c show the Allan Deviation (AD) plot of the 15μm wide pyrolytic carbon string resonator with minimum AD of 10ppm at 10 seconds.

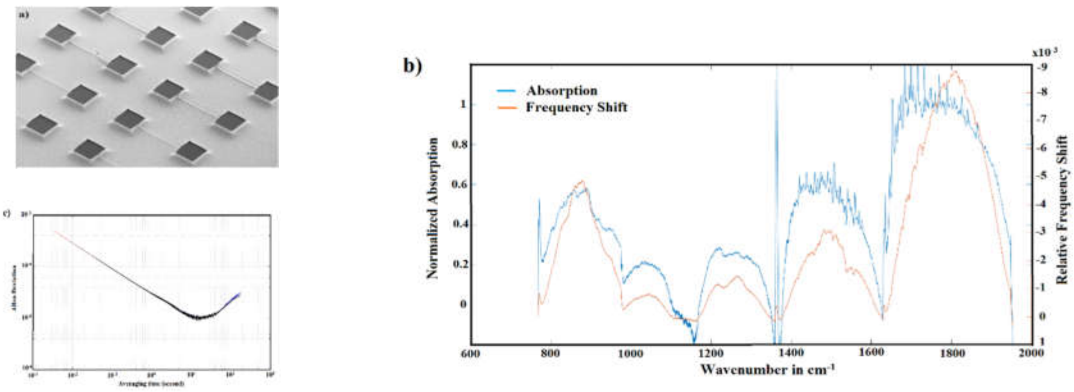

Figure 1: (a) SEM image, (b) IR absorption spectrum and (c) Allan Deviation plot of 400x15μm pyrolytic carbon string resonator.

[1] Andersen, A. J., et al (2016). *Nanomechanical IR spectroscopy for fast analysis of liquid-dispersed engineered nanomaterials*. Sensors and Actuators B: Chemical, 233, **667-673**.

[2] Kurek, Maksymilian, et al, *Nanomechanical Pyrolytic Carbon Resonators: Novel Fabrication Method and Characterization of Mechanical Properties*, Sensors, Vol. 16, No. 7, 2016, p. **1097**.