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Interactive comment on "Cavity-enhanced photoacoustic sensor based on a whispering-gallery-mode diode laser" *by* Yufeng Pan et al.

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It's my pleasure to answer your questions.

1. What is the exact role of the WGM diode laser, i.e. why WGM? I understand that the linewidths are of WGM diode lasers are much narrower than those of usual diode lasers but how do measurements at atmospheric pressure benefit from these narrow laser linewidths, i.e. what would be different if a "simple" diode laser was used?

A WGM-diode laser has a narrow linewidth, typical <200 Hz. It is true that the linewidth of gas absorption line at atmospheric pressure is typical several GHz. From this

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perspective, the measurement can not benefit from these narrow laser linewidths. However, for cavity-enhanced photoacoustic spectroscopy, laser wavelength must be locked to the resonant mode of the optical cavity to allow the energy to build up inside the cavity. The higher the finesse of the optical cavity is, the narrower the linewidth of the cavity mode will be. The WGM-diode laser with a narrow linewidth is very helpful to realize the wavelength locking, especially in the condition of a high finesse optical cavity. In our next work, we plan to design a high finesse cavity (e.g.: 5000 or 10000). Therefore, we must use an ultra-narrow linewidth laser. If a “simple” diode laser was used, it will be a challenge to complete the locking between the resonant mode of the optical cavity and the laser wavelength.

2. The detection limit for C2H2 in this paper is not outstanding. In fact, some previous results of PA detection of C2H2 were superior (see e.g.: 33.2 ppb by Yufei Ma et al. in Appl. Phys. Lett 110, 031107 (2017)). A comparison and discussion of previously achieved results for C2H2 using similar techniques is mandatory, e.g. Jingsong Li et al. in Opt. & Laser Techn. 39, 1144 (2007) or Y. Cao et al. in Appl. Phys. B 109, 359 (2012) and others. The pros and cons of the present setup with respect to previously used setups should be clearly stated and discussed in detail.

There are three reasons why our detection limit is inferior compared to that from Yufei Ma et al.. (1). In our experiment, the absorption line of acetylene that we selected was 6531.76 cm-1, which was different from the above-mentioned paper (Yufei Ma et al. in Appl. Phys. Lett 110, 031107 (2017) (6534.37 cm-1). The line strength of 6531.76 cm-1 is $\sim$3 times lower than that of 6534.37 cm-1. (2) We did not move the cavity mode to the top of the absorption line. In this way, we were detecting the C2H2 using its spectral wing, which resulted in a sensitivity loss of $\sim$3 times. (3) With the optical cavity, our effective optical power was 116 mW. But Yufei Ma used an EDFA to boost the laser power to 1500 mW.

In fact, we are more concerned with the signal enhancement from the cavity in this manuscript. Therefore, we did not pay more attention to obtaining a better minimum detection limit. After selecting the same absorption line and moving the cavity mode to the top of the absorption line, we expect to achieve a comparative detection limit with that from Yufei Ma.

As for the detection limits achieved in the above-mentioned papers (Jingsong Li et al. in Opt. & Laser Techn. 39, 1144 (2007) and Y. Cao et al. in Appl. Phys. B 109, 359 (2012)), they were 10 ppmV and 2 ppmV, respectively, which are inferior to the detection limit that we reported.

Furthermore, the cavity-enhanced photoacoustic technique we used is different from those in the above-mentioned papers, which used conventional photoacoustic spectroscopy or quartz-enhanced photoacoustic spectroscopy (QEPAS) to detect C2H2. We admit that the use of an optical cavity makes the sensor system more complicated, but it has a potential to further improve the detect limit if a higher finesse cavity is employed since the detect sensitivity is proportional to the excitation optical power. In our next work, we will use a high finesse cavity to improve the signal-to-noise ratio (SNR), thus making the detection limit better.

We will make a detail discussion regarding the pros and cons of the present setup with respect to previously used setups in our revised version.

3. Figures 1, 2, 4 and 7 could eventually be skipped without much loss of information which is given in the text.

Figures 1 and 2 describe the excellent characteristics of the WGM-diode laser about wavelength tunable ability and intensity distribution. We would like to leave Fig. 1 and 2 since they are two necessary indexes for the selection of an excitation source in PAS and CEAS. We will delete the Figure 4. Figure 7 shows a comparison of the photoacoustic signal between the CPA sensor and the CEPA sensor. The signal enhancement can be observed clearly from Fig. 7. And the stability of a constant signal can also be shown. We suggested to leave this figure.

Since questions 4-7 are about the references and minor points, we will ïňĄx them in the ïňĄnal revised version.

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