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Atmospheric Measurement Techniques
Discussions

Interactive comment on "Technical Note: Aeolian dust proxies produce visible luminescence upon intense laser-illumination that results from incandescence of internally mixed carbon" *by* L. Ma et al.

L. Ma et al.

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(Response prepared by Lulu Ma and Tingting Cao)

Anonymous Referee #1 Received and published: 26 July 2013

This paper describes luminescence from mineral dust proxies upon 532 and/or 1064nm laser illumination. Based on the spectral measurement of the luminescence from the tested materials, detected signals were attributed to the blackbody radiation (i.e., in-

candescence) from the materials heated to 4000K, which is as high as the color temperature of soot typically found in laser-induced-incandescence (LII) process. Incandescence signal per unit mass concentration of tested materials (SI) is used as an indicator for the soot content in the sample. The values of SI for dust mimics are much smaller than that for pure soot materials, indicating that the dust mimics contain a very small amount of soot (internally mixed). The note can provide the important result to suggest the usefulness of the LII technique to detect the soot-containing particles in which soot material is a very minor constituent. The contents in this note are appropriate for Atmospheric Measurement Technology, but some points raised in the following have to be addressed before acceptance.

General comments

1. Structure of the text Restructuring the manuscript especially for clarifying the robust experimental results and speculations made by the authors is strongly recommended for better readability. The section 3, "Results and discussion", should be separated into two parts (i.e., "Results" and "Discussion"). Some parts of the section 3 include experimental descriptions (e.g., P5182 Line 20-22), which should be given in the section 2 "Methods". Please see "Minor comments" in the following for the details of each sentence.

Author response: Thanks so much for the referee's time and valuable comments on this paper. We agree that some of the experiment descriptions were also shown in results part. So we have removed those sentences from results and discussion. We also divide the result and discussion section into two parts. Details could be found in answers to minor comments.

2. Composition analysis of the dust mimics used in the experiments. A lack of the composition of the dust mimics results in the uncertainty to identify the source of the luminescence. How do you consider the possibility of the co-existence of the light absorbing materials with a similar thermal properties to soot (e.g., sublimation point)?

Some metals can absorb the light at the same wavelength (1064 nm) and have similar thermal properties. In order to clarify the source of incandescence, the authors should conduct composition analysis of the dust mimics tested in this study. Another concern is the thermal transfer from heated soot to surrounding dust materials. This contributes the cooling of soot on the particle. The mass of co-existing materials (i.e. dust in this study) is much larger than that of soot. LII of soot on dust particles should be different from that from submicron soot-containing particles, which has been well investigated in a lot of previous studies (e.g., Michelson, 2003; Stephens et al. 2003; Moteki et al. 2007). How do the authors consider the effect of the amount of surrounding materials on the LII phenomena? The heating-induced fragmentation of the soot-containing dust particles can cause changes in the size distribution and number concentration by lazing (Figure 6). Therefore, the fragmented materials can be dust materials. Electro-microscopic and composition (for example, using X-ray) analysis for such fragmented particles is also helpful to verify the similarity of the results in this study with Michelson et al. (2007). See also minor comment [12] in the following.

Author response: In order to get some composition information of the bulk dust samples, we did SEM-EDS analysis on both Amarillo and Pullman samples before (included Fig. A) and after heating (included Fig. B). The results indicate the existence of C, O, Al, Si, K, Fe in both heated and non-heated samples. Unfortunately, the mass percent of C in the samples was only around 0.02% and 0.2% for heated and non-heated samples. For all these components, only carbon could be oxidized during heating and combustion and at the same time will be emitted into the air, which would results in a mass loss for the sample. For all other materials, they could also be oxidized, but will be still be in the samples, producing LII signals from laser illumination. So from the results of SEM-EDS, we still insist the LII signals were from carbon instead of other materials.

Minor comments

[1] P5175 Line1-2 Some references for the laser-induced-incandescence (LII) tech-

nique to detect BC containing particles are described before this sentence. In all of those studies, a single particle soot photometer (SP2), in which the “CW” intra-cavity laser is implemented, has been used as a detector of the BC-containing particles. Please correct this sentence and add some appropriate references to the previous studies for the similar LII BC detection techniques used in this study.

Author response: We delete references about SP2 and have added some references on applications of pulsed laser LII technique.

[2] P5178 Line4-6 The experimental description is not needed in the section of “Results and discussion”. Please move this sentence to the section of “Method”.

Author response: We moved the sentence to “Method” section.

[3] P5177 Line 22-24 Why did the authors use the combined beam for this experiment? Please describe the reason to use the different experimental setup (from other experiments).

Author response : At the beginning of this project, we would like to try and use laser light source at both 532 and 1064 nm. But the result of figure 2 indicated that 532nm light beam would give negative influence on measurements. Therefore, a filter blocking visible light was installed to remove 532nm light beam. And in the following experiments, we used 1064 nm laser only for LII.

[4] P5178 Line13-14 This sentence should be included in the figure caption. Please remove it from the main text. Author response: Done.

[5] P5178 Line19-24 The descriptions of the measured luminescence signal from the dust mimics should be moved to the next section (3.2) to directly connect the signal detection with the quantification of the concentration of BC (i.e., Quantitative characteristics of emission).

Author response: We have moved the description to section 3.2.

[6] P5180 Line 27 “inactive” Inactive to what?

Author response: It means not able to produce LII signal. It has also been corrected in revised paper.

[7] P5181 Line 3 “a per mass basis” This is actually wrong and misleading. The authors did not use an aerosol particle mass analyzer or Centrifugal Particle Mass Analyzer for classifying the mass per particle of dust particles in the experiment. Please correct this, for example, to “per unit mass concentration”.

Author response: Done.

[8] P5181 Line 16-18 Please add appropriate references to this sentence.

Author response: We moved the sentence to discussion section and have added two references in there.

[9] P5181 L23-P5182L2 These sentences include highly speculative discussions. As suggested in “General comments”, such descriptions should be moved into an independent section (ideally separated “Discussion” section).

Author response: Done.

[10] P5182 L5 “the combined 532 + 1064 nm beam” Why did the authors use the combined beam for this experiment? Please describe the reason. (Same as P5177 Line 22-24)

Author response: The green light at 532 nm was used to figure out location of laser beam, which helps to ensure that samples have been illuminated by laser beam.

[11] P5182 L 20-22 The description for the experimental setup should be given in the section of “Method”. Please remove this sentence from the section of “Results and discussion”. Author response: Removed the sentence.

[12] P5182 L 23-24 Changes in the size distribution of particles irradiated by the intense

laser (found in Figure 6) are similar to that given in Michelson et al. (2007). In this study, a large fraction of the BC-containing particles consists of dust materials, which is critically different from the case given in Michelson et al. (i.e., pure soot material). It is difficult to clarify the similarity between the results in this study and Michelson et al., unless the author investigates the composition of these fragments. One possible way to verify this point is collecting size-dependently particles (smaller than 100 nm) after lazing, observing fragmented tiny particles by an electro-microcopy, and analyzing these by EDS.

Author response: We measured different sample in our experiment. Small particles are produced by laser illumination. The appearance of small particles looks similar as Michelsen’s experiment. However, considering differences of region and source of dust samples, internal mechanism of the phenomenon in our experiment might be different from Michelsen’s . Further study is needed in order to find out the mechanism.

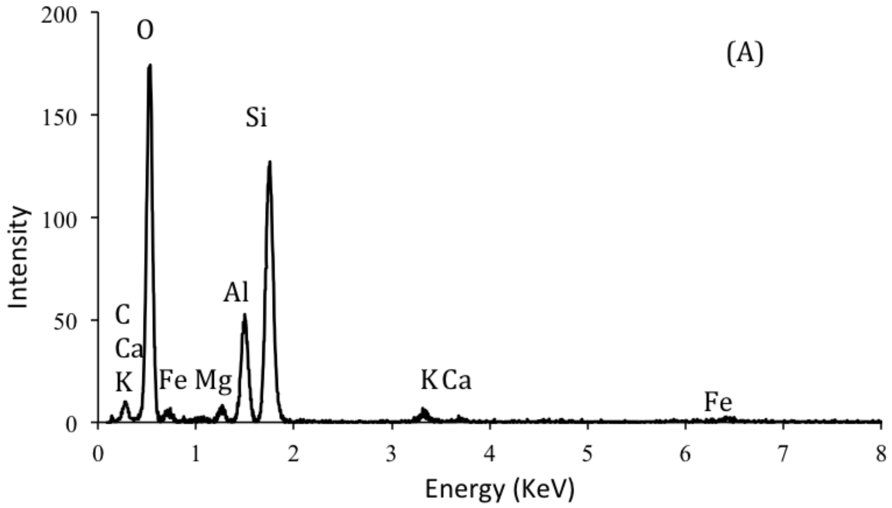
Response References Michelson, H. A. (2003), Understanding and predicting the temporal response of laser induced incandescence from carbonaceous particles, J. Chem. Phys., 118(15), 7012-7045.

Michelson, H. A., Tivanski, A. V., Gilles, M. K., van Poppel, L. H., Dansson, M. A., and Buseck, P. R. (2007), Particle formation from pulsed laser irradiation of soot aggregates studied with a scanning mobility particle sizer, a transmission electron microscope, and a scanning transmission X-ray microscope, Appl. Optics, 46, 959–977

Moteki, N., and Y. Kondo (2007), Effects of mixing state on black carbon measurements by laser-induced incandescence, Aerosol Sci. Technol., 41, 398-417.

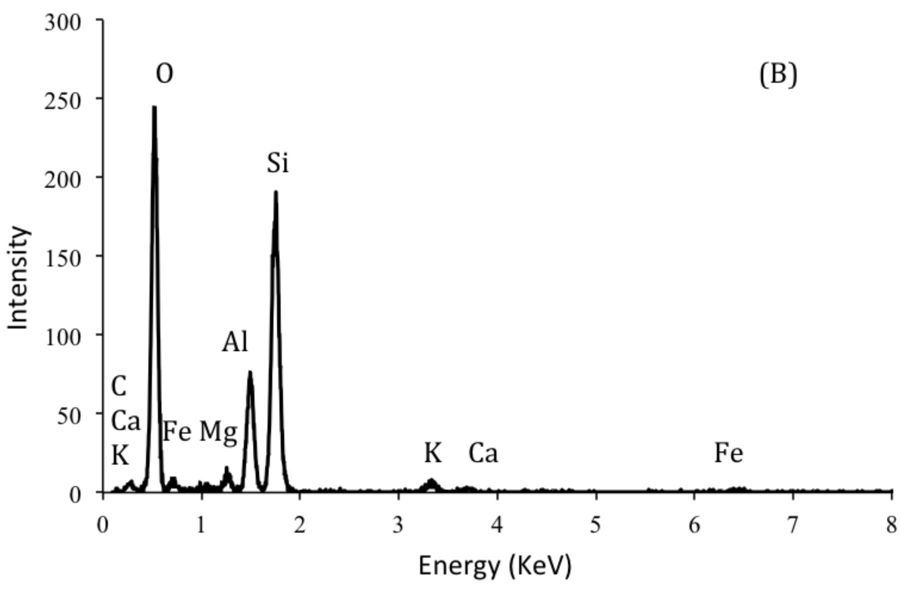
Stephens, M., N. Turner, and J. Sandberg (2003), Particle Identification by Laser-induced incandescence in a solid-state laser cavity, Appl. Opt.., 42, 19, 3726-3736.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 5173, 2013.



(A)
O
Si
Al
C
Ca
K
Fe
Mg
K
Ca
Fe
Intensity
Energy (KeV)

Fig. 1.



(B)
O
Si
Al
C
Ca
K
Fe
Mg
K
Ca
Fe
Intensity
Energy (KeV)

Fig. 2.