Dear Reviewer,

Thank you very much for carefully reviewing and constructive comments on our manuscript entitled “Tuning the doping ratio and phase transition temperature of VO₂ thin film by dual-target co-sputtering” (Manuscript ISSN 2079-4991). We studied the comments carefully and tried our best to revise and improve the manuscript according to your comments. The point by point response to your comments are listed as following:

**Point 1:** The abstract doesn't have enough information to picture the whole manuscripts such as including some results and conclusion.

**Response 1:** Many thanks for your helpful comment on the abstract and conclusion. We added "A series of samples with W doping ratio of 0%, 0.5%, 1%, 1.5% and 2% have been fabricated just by sputtering V films with power of pure and 2% W-doped V targets from 500 W :0 W, 500 W :250 W, 500 W :500 W, 250 W :500 W to 0 W :500 W respectively and then annealed in oxygen atmosphere to form VO₂. The XRD results of both pure and W doped VO₂ samples reveal that VO₂ forms and is the main component after annealing." and ", with W doping ratio from 0% to 2%" into the abstract. We also added some sentences of "It is 64.5℃ for the film of pure VO₂ film without doping and reduces with the increase of doping ratio. When the W doping ratio is 0.5%, the phase transition temperature decreases 9.5℃ to 55℃. It is lowered to 45℃ when the doping ratio increases to 1%. The phase transition temperature is further reduced to 42.5℃ when the W content increases to 1.5%. The phase transition temperature is down to 36℃ for 2% doping ratio." into the conclusion.

**Point 2:** Line 41 # "[11]. However, the films are deposited at a temperature higher than 450℃." What is the exact deposition temperature? Higher than 450 Celcius could be 454 Celcius or could be 600 Celcius. It needs to be more clear.

**Response 2:** Sorry for the improper expression. We changed it to 400℃ which is mentioned in reference [5], according to your comment.

**Point 3:** Line 59 # the sputtering system and targets weren't detailed such as brand name, model name... Line 83# "the chamber of magnetron sputtering coating system..." should given the brand name.
**Response 3:** The sputtering system used is a home-made large area magnetron sputtering system, whose photo (as shown in the following picture) and detailed information have already been reported in other place [12]. The targets we used were planar metal targets with size of 300 mm × 140 mm which were mentioned in 81# of the manuscript.

![Figure 1. Photos of the homemade large area magnetron sputtering system (a) and its targets (b).](image)

**Point 4:** Line 84 # the authors mentioned the substrate never been in an amorphous glass and then given one article with the possible both type of the glass in the introduction part. The question is what the substrate type is here? If it is glass, what type of glass is? Amorphous or others?

**Response 4:** This method is valid for fabrication of VO$_2$ thin films on both amorphous and crystalline substrates, such as glass and sapphire. The substrate we used here is amorphous glass of K9. We added it into the corresponding part of the manuscript.

**Point 5:** Line 84 # the authors wrote " to lower than $9.9 \times 10^{-4}$ Pa ". But, what is the lowest vacuum pressure. Why didn't mention the exact pressure? Is it really difficult to measure and record it? If then how can you say that these results can be reproducible?

**Response 5:** Deposition in vaccum is to avoid the collision of sputtered atoms with molecules in air and influence the quality of sputtered film. $9.9 \times 10^{-4}$ Pa is already good enough for depositing high quality thin film with good reproducibility. The vaccum pressure will decrease further with the pumping time. The lowest vacuum pressure can reach $5 \times 10^{-4}$ Pa which need almost a day to reach the equilibrium. Since the reproducibility is already
good for sputtering with vacuum lower than 9.9×10^{-4} \text{ Pa}, it does not need to pumping down to the lowest vacuum pressure by taking the efficiency into account.

**Point 6:** Line 87 #, in this line, the working pressure [I believed] mentioned that 2.1 \times 10^{-2} \text{ Pa}. If this the working pressure, and if they are using a co-sputtering system, how could solve the flux issue such very high pressure? Their method and their atomic ratio calculations can be understood/ acceptable during low pressure.

**Response 6:** Yes, you are right. 2.1\times10^{-2} \text{ Pa} is the working pressure when Argon gas with flow rate of 50 sccm was injected into the sputtering chamber as working gas. The flux issue can be controlled by a precise flowmeter. Argon is necessary in the experiment to sputter out the V and W:V atoms from the targets. It is a routine process and the working pressure can only be kept at this level when working gas injected into the sputtering chamber. Thank you.

**Point 7:** Line 89# "The targets were sputtered for 30 minutes before sputtering onto the substrate. The deposition temperature was room temperature and did not need to heat the substrate."

I do have a couple of questions here; For the first sentence, How did you handle the pre-deposition inside the chamber? Is there any sputter gun shutter to protect the sample? If there is not any shutter, how do you protect the substrate from the pre-deposition flux?

Second questions, Have you able to measure the temperature of the target during or right after the deposition via laser temp gun? How long did you deposit? After 15 minutes later, the target's temperature can be increased 15-25 Celcius which can affect the sample. Have you considered this? How did you solve this issue?

**Response 7:** Thank you for your comments. Maybe it's better for you to understand them with the system photo we provided in Point 3. For the first question, there is an independent chamber on the left side (see the photo) separated by a vaccum valve. When the sputtering chamber is pre-sputtered for 30 minutes, the sample is separated in the independent chamber. When the pre-sputtering is finished, the valve is opened. And the sample moves backward and forward within the sputtering chambers on the right side to ensure the uniformity of the film.

For the second question, the deposition principle has been shown in the schematic diagram of Figure 1. You are right. Although without heating during the deposition process, the temperature will increase gradually due to the sputtering energy. But the influence is very small and can be neglected for the sputtering time is short. Furthermore, what sputtered is V metal film (not VO$_2$ film) which is stable and the increased temperature during sputtering has little effect on the sample. Therefore, our fabrication approach is very easy to be controlled and the repeatability is higher than those approaches sputtering the VO$_2$ film directly. It is a promising approach for large-scale production of sputtering.
**Point 8:** Line 99 # The authors mentioned the resultants (I think they are the deposited substrates). Are these resultants were directly put inside the annealing furnace or did they wait outside for a while? If they waited outside for a long time, how did you handle the oxidize issue?

**Response 8:** You are right that we mentioned the resultants are the deposited substrates. After finishing the coating, the samples were directly placed into a large-diameter vacuum annealing furnace for annealing process which is near the sputtering system and in the same room.

**Point 9:** Line 114 # $2^{n-1}$ thicknesses can be realized by only n times of sputtering," Where/how did you find this formula to calculate the thickness?

**Response 9:** Sorry for writing the formula by mistake. The correct formula is $2^n-1$. By $n$ times of combinatorial depositions, $2^n$ deposition thicknesses can be formed on the substrate, including 0 nm deposition one. Therefore, $2^n-1$ thicknesses can be obtained after $n$ times of combinatorial depositions. Please see the detailed information about the combinatorial deposition technique reported in reference [22].

**Point 10:** Line 137# Figure 2; It should be better to name each of the images such as a, b, c and d. It is not clear which one is annealed images which one before annealing.

**Response 10:** Thank you for your suggestion to improve our manuscript. We have modified Figure 2 according to your comment.

**Point 11:** Line 142# Figure 3; It should be better to define the type of glass used inside the deposition.

**Response 11:** According to your suggestion, we added the type information of glass used during the deposition is K9 glass, and mentioned it in the manuscript.

**Point 12:** Line 150 # what is the phase transition temperature of this deposition?
Response 12: The phase transition temperature of VO₂ is the temperature when its phase transition occurs between the insulation phase and metal phase. It can be obtained from the optical thermal hysteresis loop of VO₂ and described in the manuscript.

Point 13: Last but not least, for the conclusion section, the atomic weight samples weren't mentioned!

Response 13: In the conclusion section, we added the change of phase transition temperature of VO₂ with different W doping ratio. We added some sentences of "It is 64.5°C for the film of pure VO₂ film without doping and reduces with the increase of doping ratio. When the W doping ratio is 0.5%, the phase transition temperature decreases 9.5°C to 55°C. It is lowered to 45°C when the doping ratio increases to 1%. The phase transition temperature is further reduced to 42.5°C when the W content increases to 1.5%. The phase transition temperature is down to 36°C for 2% doping ratio." into the conclusion.

We tried our best to modify and improve the manuscript according to your comments. And we used the “Track Changes” function in Microsoft Word to mark the revision, so that all the changes can be easily noticed by the editors and reviewers.

We appreciate for your constructive and helpful comments on our manuscript, and hope that the correction and response will meet your requirements.