**Response to the reviewer**

**Review for “FBG Multifunctional pH Sensor - Monitoring the pH Rain in Cultural Heritage”,**

***Reviewer A:***

Q1. I would remove the reference from the Abstract and start the numbering from 1 in the Introduction.

A1. Yes, we absolutely agree with this advice. We started the references from the introduction.

Q2. More references in the Introduction to describe mechanisms of materials degradation.

A2. Thank you for the useful suggestion, few other references were added to better link the material degradation and his process with prior studies and researches.

Q3. Please provide more information about the code you developed for the simulation

A3. The code used for the simulation was implemented in Comsol Multiphysics. The physic used for the study was Wave Optics. The post processing of the data was conducted with Matlab software. The statements have been added starting at the second row in the Results paragraph.

Q4. Explain better the reason why the simulation is in the pH range 4-7.1 (moreover I don’t understand why 7.1 has more significant digits).

A4. The pH range 4-7.1 was chosen for the study because the acid rain assumes on average pH values within this range and the value 4 is the minimum value that the acid rain, usually, assumes in the area where the artworks are located. Then it was interesting to show the behavior of the sensor in a range between a value immediately higher than the neutral pH and the minimum value of the acid rain that affects the artworks in order to consider all intermediate scenarios too. Moreover the main reason why this range was also considered was because the hydrogel shows a strain uniformly distributed within it. This provides a linear response of the sensor.

Q5. Please provide more information about materials that could be used for the sensor.

A5. The fiber Bragg grating is constituted, in the original configuration, by two different dielectric materials with nh=2.32 and nl=1.38 as refractive index, corresponding to Zinc Sulfide and Magnesium Fluoride respectively. Both have great features as optical materials, that’s why they were chosen to constitute the FBG sensor. The cladding is a glassy material with refractive index equal to 1.444.

In the sensor variant, 3 different nh values were considered - 1.4, 2.2 and 3 - without defining specific materials. The goal was to analyze the behaviour of the system and to highlight its performances. It was discovered that the higher the difference between the refractive index of the two materials that constitute the grating, the higher the peak reflection, even if with a much wider stop-band.

Q6. I don’t understand the meaning of the second and third graph in Figure 5, because on the vertical axis there is always the same value.

A6. Figure 5 depicts the peak of the percentage reflection in the range of pH 4–7.1. Increasing the number of layers from 5 to 21 results in an increase of the reflectance of the initial light intensity, while maintaining the same pattern. Thank you for the observation, Figure 5 was updated in the paper in order to show the other significant digits on the vertical axis of the second and third graph.

In the figure we are showing an increase of reflectance with an increase of layers constituting the grating. For 11 layers, the reflectance peak, in the pH range of 4 and 7.1, is around 99.3838, as shown in the figure 5 the values are inside a narrower band and for clarity of the picture the more significant digits were omitted. While for 21 layers the reflectance peak is around 99.9966, in the pH range of 4 and 7.1, and again the more significant digits were omitted for clarity of the figure. We confirmed that the higher is the number of layers the higher is the reflectance.

Q7. Report more precisely in the Discussion Section the limitations due to temperature and bending cross-sensitivities.

A7. We thank the reviewer for the constructive observation. The following statement was inserted inside the paper starting to the row 21st of the Discussion section. “The wavelength drift of the FBG sensor is also induced by bending cross-sensitivity and temperature changes. In this paper these two effects have not been considered. The temperature and strain parameters will be taken into account for the next generation of FBG pH sensors. These will be compensated with either two further FBG sensors or a single FBG sensor able to measure both temperature and strain simultaneously. The dedicated system will be placed in series in the measurement chain. As temperature and strain sensors, FBGs have a fast response time due to their small size and volume. Knowing the real time outputs of the sensors for the temperature and strain changes, it will be possible to accurately measure the variation of pH of the material under analysis, subtracting the effect of these two quantities.”

**Q8.** In the Discussion session provide an estimation of the real dimensions of the complete device (even if dimensions of the sensor alone are provided in the Introduction).

**A8.** Thank you for the good suggestion, the estimation of the real dimensions of the device was added in the Discussion section too on the 37th row.

**Q9**. I would move the part that currently is under Discussion section to the Conclusion and write the Discussion session anew, providing comments on results and explaining differences between different studied sensors. A real discussion of obtained results is missing.

**A9**. Thank you for the careful analysis on the Discussion and the suggestion of moving the original part to the Conclusion section. The Discussion paragraph has been written anew, comments on the results and different sensors were provided.

**Q10.** Please provide an evaluation of the accuracy of the model.

**A10.** The model was generated with Comsol Multiphysics, Wave Optics has been the physics used in the study. The accuracy of the model is defined by Comsol and the related Module after the verification and validation process of the software. The post processing of the data was conducted with Matlab software.

**Q11.** Eventually it would be interesting for the reader to see a comparison with measurements performed with the sensor or literature data

**A11.** The results of our simulations show a sensitivity higher than other sensor in literature. For example in the “I. Yulianti, A.S.M. Supa'at, and S.M. Idrus, “Characterization of fiber Bragg grating sensor for pH measurement,” Advanced Intelligent Mechatronics (AIM), IEEE/ASME International Conference on, Besançon, France, (2014), pp. 1163-1166” the figure 3 shows the sensor response from their simulation and experiment. Comparing our Figure 4 to the Figure 3 of Yulianti’s paper can be noticed a different sensitivity of the sensors, with higher sensitivity for ours. There are some reasons for this result, mainly our model was set to perform to the best in the range 4-7.1 under analysis, and moreover some ideal conditions were imposed to optimize the sensor outcomes.

***Reviewer B:***

**Q1.** Pag. second column line 3 change: sufates with sulfates

**A1.** Thank you for the correction. The word was corrected.