the peaks shapes when this effect is not taken into account. Finally, further analysis is currently under way to improve the correlation between numerical and experimental data.

6. Conclusions

In summary, we have reported the first evidence of the resonant behavior of an underwater acoustic sensor constituted by an FBG coated by a ring-shaped material. We have carried out a full 3-D numerical analysis of this acoustic sensor in the frequency range 0.5-30 kHz, thereby extending previous studies on coated FBGs [12] limited to approximate hydrostatic modeling.

Our numerical results fully characterize the opto-acoustic response of the optical hydrophone, and indicate that the coating may significantly enhance the sensitivity over the whole investigated frequency range, by comparison with an uncoated FBG. The excitation of characteristic resonances (at frequencies related to the physical and geometrical parameters) of the cylindrical coating further improves the sensor performance. With the aid of modal analysis, we have associated the frequency peaks with longitudinal vibration modes supported by the coating. In particular, under normally-incident plane wave excitation, the structure exhibits sensitivity peaks associated to symmetric longitudinal modes, whereas anti-symmetric modes may also excited under oblique incidence.

The results from our comprehensive parametric studies also indicate that the coating height and radius may be effectively utilized in order to tune the resonant frequencies. Furthermore, larger coating radii may be beneficial in improving the low-frequency background sensitivity, but detrimental in the high-frequency region. In connection with the coating elastic properties, low values of the Young's modulus, Poisson's ratio, and density are desirable for enhancing the sensitivity, and the detrimental effect of structural damping on the resonant peaks needs to be carefully accounted for.

Several aspects emerged from this study (e.g., the resonant behavior of the acoustic sensor, as well as the diffraction-related effects of the radius increase) could have not been predicted by the hydrostatic model utilized in [12,14]. Our full-wave numerical analysis, besides providing a physical insight in the interaction between the impinging acoustic wave and the sensor, also gives useful hints and guidelines for the design and performance optimization towards specific applications. For instance, the resonant behavior can be better exploited in active acoustic sensing applications whereas the sensor behavior in a frequency range away from the resonances seems better suited for passive acoustic sensing.

Finally, a preliminary validation of the proposed numerical analysis has been carried out through experimental data obtained using polymeric coated FBGs sensors. As matter of fact, a good agreement between the experimental characterizations and the numerically predicted sensitivity gains has been obtained, confirming the correct modeling of the hydrophone as well as its prediction capability.

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