Higher energy-ranged PL scans of intended ZnO-MgZnO core-shell nanowires demonstrating Mg content

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Abstract

Three samples of intended ZnO-MgZnO core-shell nanowires, grown by Maria Viitaniemi in November 2019, were scanned by photoluminescence. The scan range was over higher energies which revealed a Mg peak for two of the samples, H1088 and H1090. These two samples had N_2O and O_2 respectively as shell precursors, both grown at 605 C. As a control, two samples of baseline ZnO nanowires were also scanned for the same range, revealing a lack of such a Mg peak.

I. GROWTH CONDITIONS AND SAMPLE LABELLING

Table I shows the growth conditions for the three samples with intended MgZnO shells. The other two samples shown in this report are baseline growths: H1108 was a standard baseline and H1107 was a two hour standard baseline growth.

Sample	Shell Precursors	TG (shell)
H1088	DEZn,CP2Mg,N2O	605C
H1090	DEZn, CP2Mg, O2 (100%)	605C
H1092	DEZn, CP2Mg,O2 (50%)	505C

TABLE I. Table summarizing the growth conditions for the intended ZnO-MgZnO core-shell nanowires.

II. SPECTRA AND OBSERVATIONS

The PL spectra are plotted below. The colour scheme reflects the amount of Mg content in the sample, with cool colours assigned to the baseline growths and H1092, which had no Mg peak.

Figure 1 shows that there is a clear Mg peak for samples H1090 and H1088. These are the samples grown with N_2O and 100% O_2 respectively as shell precursors, both at 605 °C. Based on Fig. 4 from [1], the positions of these broad peaks suggest that these samples both have less than 1% Mg content.

Figure 2 shows the same data as Fig. 1 but in a smaller range focusing on the usual ZnO structures. The In peak of all five spectra are in agreement, as well as for the Ga peak. For H1088, the sample with the most Mg content, there is another peak visible at an energy slightly higher than the Ga peak.

Furthermore, the surface excitons are blue-shifted in the Mg coated samples compare to

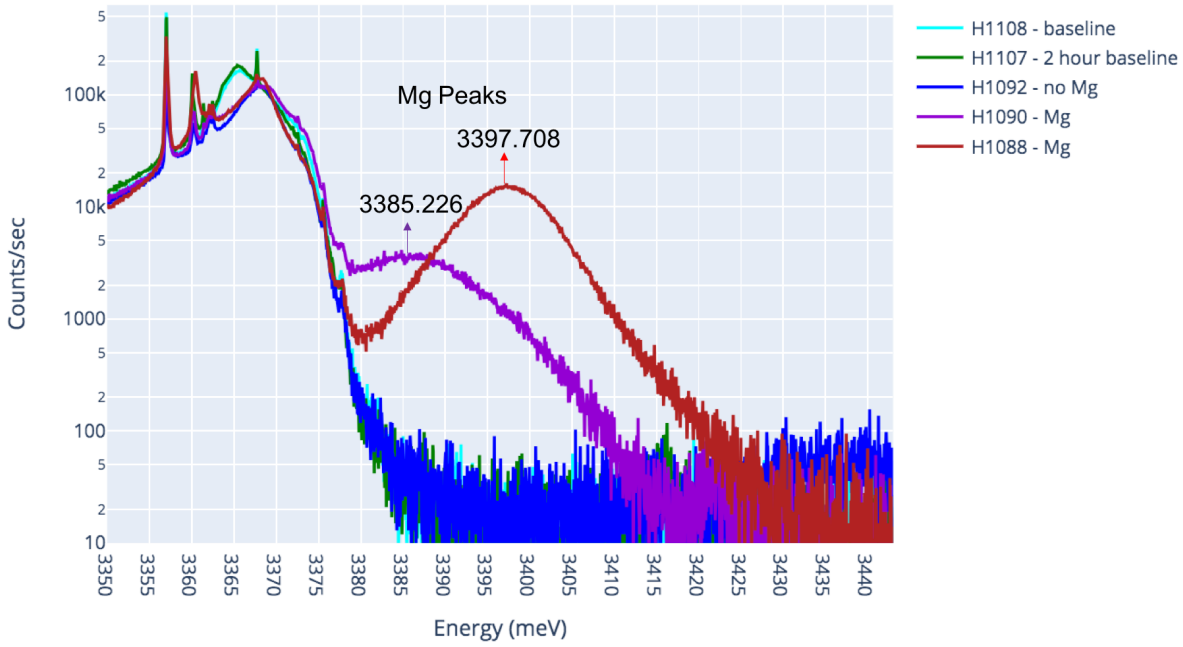

FIG. 1. The PL spectra of all five samples, shown over the full range of energies in which the data was collected. The intensity is in log, which clearly shows a Mg peak for H1090 and H1088.

those in the baseline samples. It is interesting to note that even H1092, which had intended to have Mg content but does show any Mg peak, also has a blue-shifted surface exciton. This suggests that its growth conditions had a similar effect on its surface excitons despite the evidence for lack of Mg. Regardless, the intensity of the surface excitons are slightly weaker in the ZnO-MgZnO core-shell samples than in the baselines.

Another trend is such that the baseline growths both have significantly higher In ion peaks than the other three ZnO-MgZnO core-shell samples.

Figure 3 shows again the same data but with a linear intensity axis.

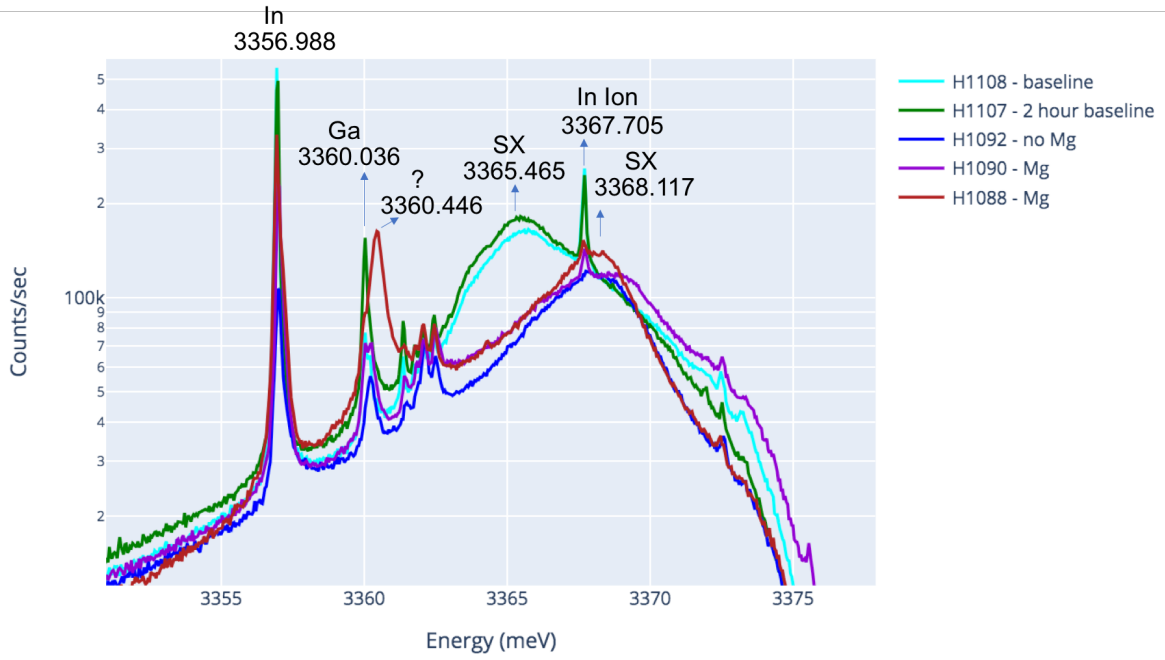

FIG. 2. A subset of the logarithmic PL spectra, focusing on a smaller energy range from 3350 meV to 3375 meV to highlight the usual ZnO structures. In, Ga, In ion and surface exciton peaks are visible.

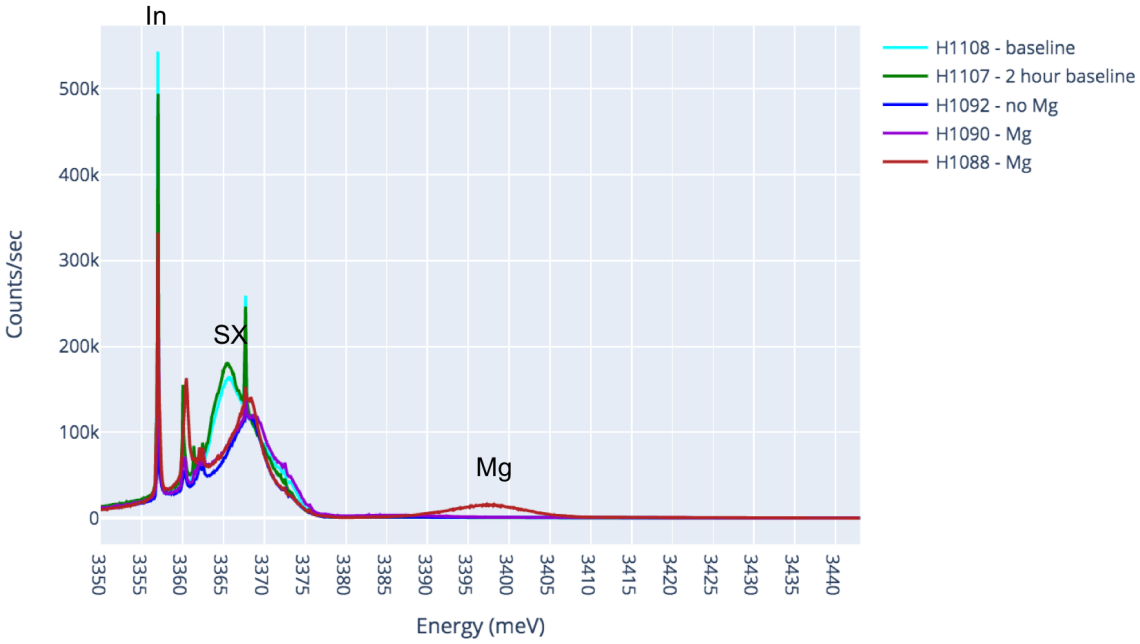

FIG. 3. PL spectra of the five samples, in linear intensity scale.

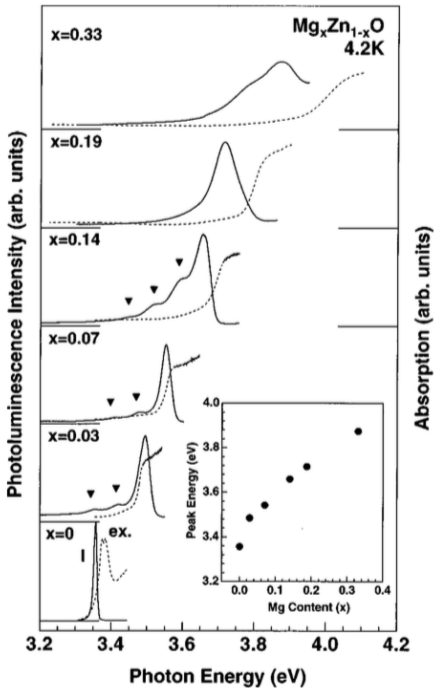

FIG. 4. PL spectra (solid lines) of MgZnO thin films based on Mg content. The Mg peaks are blue-shifted with more Mg content. Taken from [1].

III. CONCLUSION

In conclusion, to grow more Mg heavy core-shell structures, we would need to increase the molar flow of CP2Mg source by increasing the temperature of the Mg. The most promising candidate is the N_2O precursor. The surface exciton seems to also be affected by the growth conditions and Mg content.

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[1] Appl. Phys. Lett. 72, 2466 (1998); https://doi.org/10.1063/1.121384