Figure S1. XRD patterns of several different stoichiometries with ICP-OES analysis, showing the shift in peak positions with changing Co-Mn content. Sample (a) is from the reaction shown in Figure 6a; (b) is from the reaction shown in Figure 1d; (c) is from the reaction shown in Figure 6e; (d) is from the reaction shown in Figure 6g. c-MnO and c-CoO are shown in red and blue, respectively.
**SI-1. Change in lattice parameters with Mn:Co content**

Based on Vegard’s Law, the unit cell parameters of a solid solution should change linearly based on its composition. Using data from JADE 9, XRD peaks and patterns of cubic-lattice products were fitted to Gaussian curves and used to refine unit cell data. Both peak positions and unit cell volumes were plotted against the Co fraction of the oxide, taken from ICP-OES. In the cases where metallic cobalt was present in the XRD pattern, whole-pattern fitting (WPF) refinement was utilized to determine the amount of cobalt metal present and correct the elemental analysis. The (220) peak was chosen as the indicator for the peak position graph due to its moderate-to-high intensity and the fact that it shifts position the most based on changing unit cell parameters. Attempts to determine lattice constants for hexagonal lattice products were frustrated by low crystallinity and small crystallite sizes, which caused most diffraction patterns to have poor signal to noise ratios and very broad peaks.

The data shows a good linear correlation between both the (220) peak position and calculated cell volume versus Co content. As Vegard’s Law is not exact, a perfect correlation is not expected. The main possible sources of error are the presence of trace amounts of metallic cobalt, secondary phases of $\text{Co}_{1-x}\text{Mn}_x\text{O}$ and amorphous material. Metallic cobalt diffraction peaks could sometimes be identified at $2\theta = 44^\circ$ and $47^\circ$, arising from the cubic and hexagonal close pack forms of metallic Co, respectively; secondary cubic oxide phases occasionally presented as shoulders in the XRD patterns of the material; and no amorphous materials would give diffraction peaks to indicate their occurrence. Any of these three would be side products that could have their metal content analyzed in the ICP-OES experiment.
Figure S2. Correlation of (220) peak position with Co fraction (from ICP-OES data). MnO and CoO are included as references; the direct-line correlation between the two is in red.

Figure S3. Calculated unit cell volume compared to Co fraction (from ICP-OES). MnO and CoO are included as references in the data; the direct-line correlation between the two is in red.
SI-2. \( Co_{0.9}Mn_{0.10} \) rods and branched rods

Some of the rods (Figure 11b) lack the characteristic barbell heads at each end as seen in MnO. The maximum number of “arms” per particle is three, resembling a “T”; a higher magnification image of one such branched particle is shown in Figure 11c. The SAED pattern (inset of Figure 11d) of this particle shows only diffraction from one set of cubic lattice planes, indicating that it is a single crystal. The arms of this branched particle are considerably shorter than those seen in Figure 11a and b (50 nm vs. 150 nm), indicating a particle in a different stage of growth than the larger ones. Additionally, the arms of the branched particle are aligned with the \(<001>\) diffraction spots, indicating that the arms have grown from the faces of the original cubic seed. Similarities in morphology between MnO and c-\( Co_{1-x}Mn_x \)O under these conditions suggest similar growth processes are occurring in each case. However, the introduction of cobalt to the reaction limits the number of faces of the initial seed from which the arms grow. These factors support our hypothesis that the process of MnO hexapod formation is based on a core nucleation-dendritic arm growth mechanism.\(^{11-13}\)
Figure S4. XRD pattern of supernatant product from reaction condition 6 mL TOA: 2 mL OA, 0.5 mmol of each Co and Mn precursor (as in Figure 12b). Reference pattern for $Fm\bar{3}m$ lattice with $a = 4.3$ Å is shown in blue; reference $P6_3mc$ lattice with $a = 3.2$ Å and $c = 5.2$ Å shown in green.

**SI-3, Growth time**

The stoichiometries of the particles from Figure 10 are shown in Table S1. More cobalt is present in the samples that precipitated from hexanes than those that remained in the supernatant. Additionally, extending the growth time led to greater amounts of cobalt present than at shorter growth times. These results are in agreement with our hypothesis that the relative amounts of each metal incorporated into the oxide lattice correlates to the relative solubilities of hydroxide intermediates.

<table>
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<th>2 min</th>
<th>5 min</th>
<th>10 min</th>
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<tbody>
<tr>
<td>SN</td>
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<td>Co$<em>{0.49}$Mn$</em>{0.51}$</td>
<td>Co$<em>{0.56}$Mn$</em>{0.44}$</td>
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<tr>
<td>ppt</td>
<td>N/A</td>
<td>Co$<em>{0.52}$Mn$</em>{0.48}$</td>
<td>Co$<em>{0.64}$Mn$</em>{0.36}$</td>
</tr>
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Figure S5. Change in XRD patterns for the material collected from the supernatant of reactions with extended growth times under conditions 6 mL TOA: 2 mL OA, no water and 0.5 mmol each of Co(OAc)$_2$ and Mn(HCOO)$_2$. Reference pattern for a rock salt lattice with $a = 4.3$ Å is shown in blue; reference $P6_3mc$ lattice with $a = 3.2$ Å and $c = 5.2$ Å shown in green.