## Doping Homogeneity in Co-doped Materials Investigated at Different Length Scales

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## **Supporting information**



## 1. EDX mappings

Figure S1: Electron micrographs detected via backscattered electrons (top left) and EDX mappings (top right and bottom) of  $La_{0.94}Nd_{0.03}Tm_{0.03}PO_4$ . The acceleration voltage is 30 kV.



Figure S2: Electron micrographs detected via backscattered electrons (top left) and EDX mappings (top right and bottom) of  $La_{0.9}Gd_{0.05}Dy_{0.05}PO_4$ . The acceleration voltage is 30 kV.



Figure S3: Electron micrographs detected via backscattered electrons (top left) and EDX mappings (top right and bottom) of La<sub>0.92</sub>Nd<sub>0.04</sub>Ho<sub>0.04</sub>PO<sub>4</sub>. The acceleration voltage is 30 kV.



## 2. NMR visibility maps

Figure S4: the NMR visibility map calculated from <sup>31</sup>P MAS NMR data plotted against the substitution degree *x* and *y* in  $La_{1\cdot x \cdot y}Gd_xDy_yPO_4$  on a logarithmic scale. The dashed 3D plot (left) and its contour plot (right) feature the expected visibility function  $f(x,y) = \exp[-a(r_{Gd}^3x + r_{Dy}^3y)]$  with the values  $a = 0.055/Å^3$ ,  $r_{Gd} = 13.5$  Å and  $r_{Dy} = 12.5$  Å being the same as for mono-doped LaPO4. The contour levels were chosen according to the expected value for f(x,y) at the point (x,y).



Figure S5: the NMR visibility map calculated from <sup>31</sup>P MAS NMR data plotted against the substitution degree *x* and *y* in  $La_{1-x-y}Nd_xTm_yPO_4$  on a logarithmic scale. The dashed 3D plot (left) and its contour plot (right) feature the expected visibility function  $f(x,y) = \exp[-a(r_{Nd}^3x+r_{Tm}^3y)]$  with  $a = 0.055/Å^3$ ,  $r_{Nd} = 5.5$  Å and  $r_{Tm} = 9$  Å being the same as for mono-doped LaPO4. The contour levels were chosen according to the expected value for f(x,y) at the point (x,y).