Supplementary Information

Hydrothermal synthesis of one-dimensional yttrium hydroxide particles by a two-step alkali-addition method

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1. Transformation of the 1D $Y(OH)_3$ particles into 1D Y_2O_3 particles by calcination

The 1D $Y(OH)_3$ particles prepared under the typical condition were calcined to transform them into Y_2O_3. The freeze-dried powder of the 1D $Y(OH)_3$ particles were placed in a porcelain crucible and heated to dehydrate in a muffle furnace at 500 °C for 2 h. The TEM image in Fig. S1 shows the 1D shape is fairly maintained even after the dehydration reaction. The XRD pattern (Fig. S2) indicates the $Y(OH)_3$ is completely converted to cubic Y_2O_3 (JCPDS 71-0049) by the calcination process.

Fig. S1 TEM image of the 1D Y_2O_3 particles calcined at 500 °C for 2 h from the 1D $Y(OH)_3$ particles.

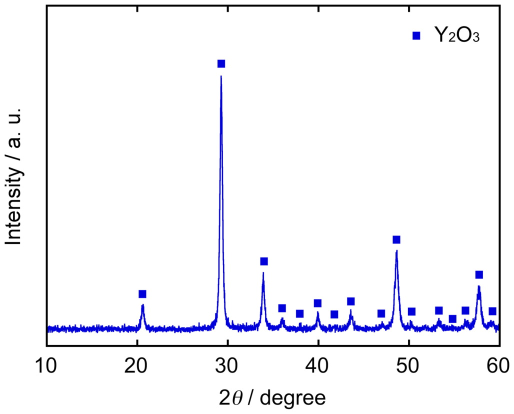

Fig. S2 XRD pattern of the 1D-particles after the calcination process at 500 °C for 2 h. All the peaks are matched with the standard ones of cubic Y_2O_3 (JCPDS 71-0049).

2. Determination procedures of Y^{3+} and Cl^{-} ions in the supernatant solution

2. 1. Sample preparation

For each condition of V_{NaOH}, this volume of NaOH solution (1 mol L^{-1}) was added into 14 mL of YCl_3 solution (0.071 mol L^{-1}) at 25 °C under magnetic stirring. After separating the precipitate by centrifuge at 10000 rpm (12000 × *g*) for 30 min, the supernatant solution was carefully collected from the centrifugal tube.

2.2. Colorometric determination of Y^{3+} ion

To determine the Y^{3+} ion content, xylenol orange (XO), purchased from Dojindo, was employed as the coloring agent of Y^{3+} ion.[S1] Into a volumetric flask (20 mL), 2 mL of acetate buffer (pH 4.6) that contained 0.25 mol L^{-1} of CH_3COOH and 0.25 mol L^{-1} of CH_3COONa, a certain volume of Y^{3+} standard solution or sample one, and 2 mL of XO solution (1×10^{-3} mol L^{-1}) were introduced in this order. After adjusting to 20 mL with distilled water, the absorption spectrum was measured by a spectrophotometer (Shimadzu Multispec-1500).

Since the initial YCl_3 concentration is as high as 0.071 mol L^{-1}, the sample supernatant solution was suitably diluted with distilled water to being applied to determination for the conditions $V_{NaOH} = 0 \sim 2$ mL, while it was used as-is for $V_{NaOH} \geq 2.5$ mL.

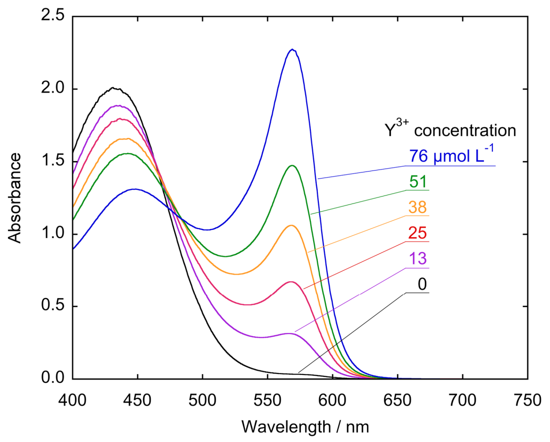

Fig. S3 Absorption spectra of Y^{3+} standard solution colorized with XO in an acetate buffer (pH 4.6).

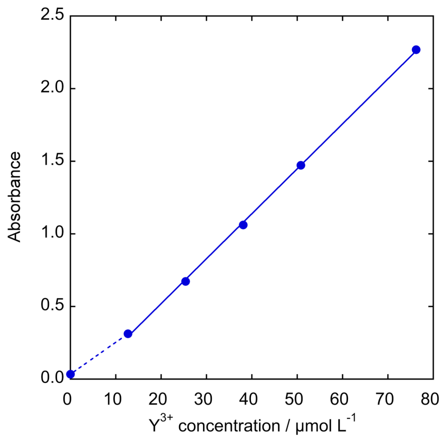

Fig. S4 Relationship between Y^{3+} concentration and absorbance at 568 nm.

Fig. S3 shows the dependence of absorption spectrum on the Y^{3+} concentration. Along with the increase of Y^{3+} concentration, absorbance at 568 nm, attributed to Y^{3+}-XO complex, is increased, while absorbance at 430 nm, attributed to XO, is decreased. As isobestic point is not found in Fig. S3, more the two kinds of complex species could be formed. However, the absorbance at 568 nm indicates a sufficient linearity to Y^{3+} concentration at least in the range of 13 ~ 76 μmol L^{-1} (Fig. S4).

2.3. Potentiometric titration for determination of Cl^{-} ion

To determine the Cl^{-} content, potentiometric titration using $AgNO_3$ solution was carried out. Into 30 mL of distilled water, 2 mL of an acetate buffer (pH 4.6) that contains 0.25 mol L^{-1} of CH_3COOH and 0.25 mol/L of CH_3COONa and 2 mL of sample solution were added, where the acetate buffer was used to avoid possible formation of Ag_2O precipitate in high pH samples. By measuring Ag^{+} potential with a Ag_2S-coated Ag electrode, 0.05 mol L^{-1} of $AgNO_3$ was introduced drop-by-drop from a bullet to determine the equivalent point of each sample solution.

Reference

S1 A. Hrdlička, J. Havel, C. Moreno and M. Valiente, *Anal. Sci.*, 1991, **7**, 925-929.