

The type IV polymorph of  $\text{KEu}(\text{PO}_3)_4$ Abdelghani Oudahmane,<sup>a</sup> Mohamed Daoud,<sup>a</sup>  
Boumediene Tanouti,<sup>a</sup> Daniel Avignant<sup>b</sup> and Daniel  
Zambon<sup>b\*</sup><sup>a</sup>Université Cadi Ayyad, Laboratoire de Physico-Chimie des Matériaux et Environnement, Faculté des Sciences Semlalia, Département de Chimie, BP 2390, 40000, Marrakech, Morocco, and <sup>b</sup>Université Blaise Pascal, Laboratoire des Matériaux Inorganiques, UMR CNRS 6002, 24 Avenue des Landais, 63177 Aubière, France

Correspondence e-mail: daniel.zambon@univ-bpclermont.fr

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Key indicators: single-crystal X-ray study;  $T = 296$  K; mean  $\sigma(\text{P}-\text{O}) = 0.002$  Å;  $R$  factor = 0.030;  $wR$  factor = 0.072; data-to-parameter ratio = 38.0.

Single crystals of  $\text{KEu}(\text{PO}_3)_4$ , potassium europium(III) polyphosphate, were obtained by solid-state reactions. This monoclinic form is the second polymorph described for this composition and belongs to type IV of long-chain polyphosphates with general formula  $A^I B^{III}(\text{PO}_3)_4$ . It is isotypic with its  $\text{KEr}(\text{PO}_3)_4$  and  $\text{KDy}(\text{PO}_3)_4$  homologues. The crystal structure is built of infinite helical chains of corner-sharing  $\text{PO}_4$  tetrahedra with a repeating unit of eight tetrahedra. These chains are further linked by isolated  $\text{EuO}_8$  square antiprisms, forming a three-dimensional framework. The  $\text{K}^+$  ions are located in pseudo-hexagonal channels running along  $[\bar{2}01]$  and are surrounded by nine O atoms in a distorted environment.

## Related literature

Besides crystals of the title compound, crystals of the type III polymorph (Hu *et al.*, 1984) have also been obtained. For isotypic  $AB(\text{PO}_3)_4$  structures, where  $A$  is an alkali metal, Tl or  $\text{NH}_4^+$ , and  $B$  is a rare earth element, see: Palkina *et al.* (1977) for TlNd; Maksimova *et al.* (1978) for RbNd; Dago *et al.* (1980) for KEr; Maksimova *et al.* (1981) for CsNd; Maksimova *et al.* (1982) for RbHo; Horchani *et al.* (2004) for RbEr; Rekik *et al.* (2004) for KGd; Naili & Mhiri (2005) for CsGd; Ben Zarkouna *et al.* (2006) for  $(\text{NH}_4)\text{Gd}$ ; Khliissa & Férid (2006) for RbTb; Ettis *et al.* (2006) for RbGd; Chehimi-Moumen & Férid (2007) for KDy; Horchani-Naifer & Férid (2007) for CsPr; Zhu *et al.* (2009) for CsEu. For a review on the crystal chemistry of polyphosphates, see: Durif (1995). Jaouadi *et al.* (2003) have discussed the main crystal chemical characteristics of the seven  $AB(\text{PO}_3)_4$  structure types. For applications of rare earth polyphosphates, see: Rashchi & Finch (2000); Barsukov *et al.* (2004). For general background, see: Porai-Koshits & Aslanov (1972). For ionic radii, see: Shannon (1976).

## Experimental

## Crystal data

$\text{KEu}(\text{PO}_3)_4$	$V = 968.73(2) \text{ \AA}^3$
$M_r = 506.94$	$Z = 4$
Monoclinic, $P2_1/n$	Mo $K\alpha$ radiation
$a = 10.3723(1) \text{ \AA}$	$\mu = 7.63 \text{ mm}^{-1}$
$b = 8.9721(1) \text{ \AA}$	$T = 296 \text{ K}$
$c = 10.8320(1) \text{ \AA}$	$0.12 \times 0.11 \times 0.10 \text{ mm}$
$\beta = 106.053(1)^\circ$	

## Data collection

Bruker APEXII CCD diffractometer	24299 measured reflections
Absorption correction: multi-scan (SADABS; Bruker, 2008)	6201 independent reflections
$T_{\min} = 0.466$ , $T_{\max} = 0.513$	5023 reflections with $I > 2\sigma(I)$
	$R_{\text{int}} = 0.045$

## Refinement

$R[F^2 > 2\sigma(F^2)] = 0.030$	163 parameters
$wR(F^2) = 0.072$	$\Delta\rho_{\text{max}} = 1.72 \text{ e \AA}^{-3}$
$S = 1.04$	$\Delta\rho_{\text{min}} = -2.04 \text{ e \AA}^{-3}$
6201 reflections	

## Table 1

Selected bond lengths (Å).

P1—O7	1.480 (2)	P3—O6	1.482 (2)
P1—O4 <sup>i</sup>	1.483 (2)	P3—O2	1.4873 (19)
P1—O12	1.588 (2)	P3—O11	1.6005 (19)
P1—O3 <sup>ii</sup>	1.5968 (19)	P3—O1	1.6033 (19)
P2—O10 <sup>iii</sup>	1.4795 (19)	P4—O9	1.4784 (19)
P2—O5	1.483 (2)	P4—O8 <sup>v</sup>	1.484 (2)
P2—O11 <sup>iii</sup>	1.6015 (18)	P4—O1	1.601 (2)
P2—O3 <sup>iv</sup>	1.602 (2)	P4—O12 <sup>iii</sup>	1.601 (2)

Symmetry codes: (i)  $-x + \frac{3}{2}, y + \frac{1}{2}, -z + \frac{1}{2}$ ; (ii)  $x + 1, y, z$ ; (iii)  $-x + 1, -y + 2, -z$ ; (iv)  $x + \frac{1}{2}, -y + \frac{3}{2}, z - \frac{1}{2}$ ; (v)  $x - \frac{1}{2}, -y + \frac{3}{2}, z - \frac{1}{2}$ .

Data collection: APEX2 (Bruker, 2008); cell refinement: SAINT (Bruker, 2008); data reduction: SAINT; program(s) used to solve structure: SHELXS97 (Sheldrick, 2008); program(s) used to refine structure: SHELXL97 (Sheldrick, 2008); molecular graphics: DIAMOND (Brandenburg, 1999); software used to prepare material for publication: SHELXTL (Sheldrick, 2008).

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: WM2282).

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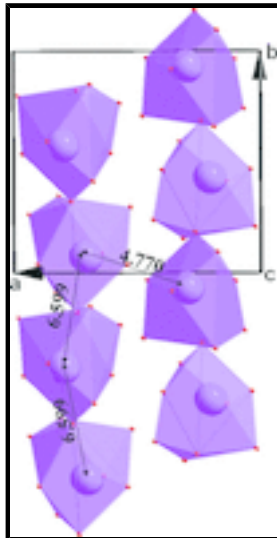


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