Supporting Information

Predicting the Optical Pressure Sensitivity of $^{2}E \rightarrow {}^{4}A_2$ Spin-Flip Transition in Cr^{3+}-doped Crystals

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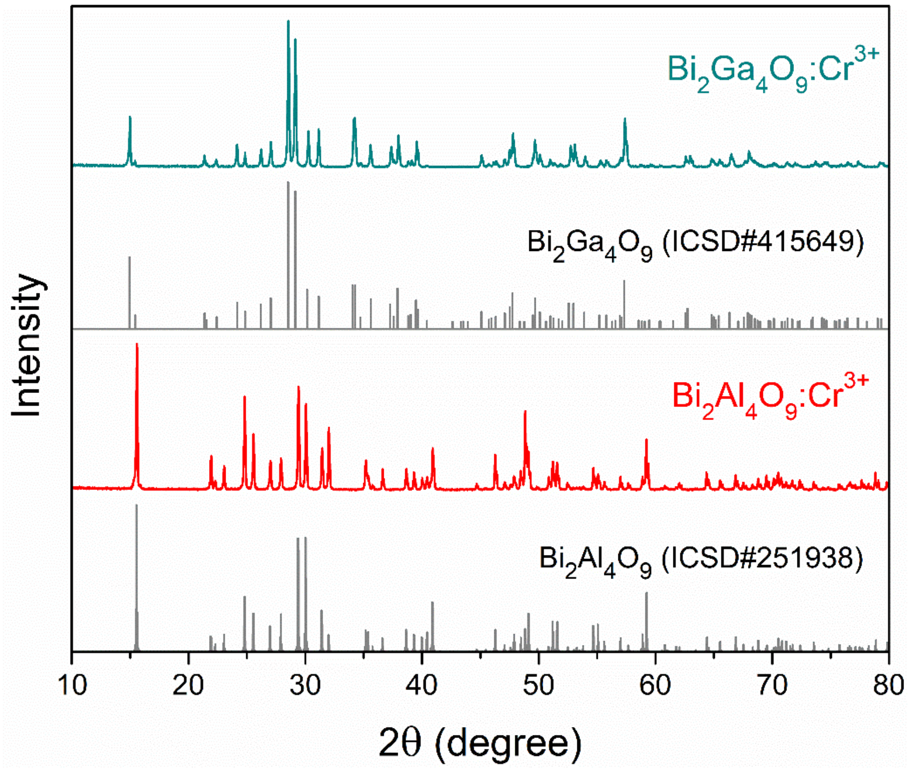

Figure S1. XRPD patterns of $Bi_2M_4O_9:Cr^{3+}$ (M= Ga, Al) systems.

Crystal field strength 10*Dq* and Racah *B* and *C* parameters calculation

In the framework of Tanabe-Sugano theory, the crystal field strength $10Dq$ and the Racah parameters B and C were calculated from the spectroscopic measurements by means of the following equations:

$$10Dq = E(\,^4\mathrm{A}_2 \rightarrow \,^4\mathrm{T}_2) \qquad (S2)$$

$$B = \frac{\dfrac{\left(\Delta E_{\,^4\mathrm{T}}\right)^2}{Dq} - 10\Delta E_{\,^4\mathrm{T}}}{15\left(\dfrac{\Delta E_{\,^4\mathrm{T}}}{Dq} - 8\right)} \qquad (S3)$$

$$C = \frac{E(\,^2\mathrm{E})}{3.05} - \frac{7.9B}{3.05} + \frac{1.8}{3.08}\left(\frac{B^2}{Dq}\right) \qquad (S4)$$

where $\Delta E_{\,^4\mathrm{T}} = E(\,^4\mathrm{T}_{1g}) - E(\,^4\mathrm{T}_{2g})$ is the energy difference between the $^4\mathrm{T}_{1g}$ and $^4\mathrm{T}_{1g}$ states.

Table S1. Pressure sensitivity $\frac{d\,^4T_2}{dp}$ for the $^4T_2 \rightarrow ^4A_2$ transition (broadband) and bulk modulus B_0 for Cr^{3+} ion in various hosts.

Compound	$\frac{d\,^4T_2}{dp}$ (cm^{-1}kbar^{-1})	B_0 (kbar)	Ref.
Cs_2NaYCl_6	25.7	194.5	[1,2]
$Cs_2NaScCl_6$	28	231	[3,4]
K_2NaScF_6	17.6	453	[5,2]
K_2NaGaF_6	18	513	[6,2]
$KZnF_3$	17.9	776	[7,8]
$LiTaO_3$	13.5	1057	[9,10]
$LiNbO_3$	13.5	1058	[11,10]
$La_3Lu_2Ga_3O_{12}$	10	1330	[12,13]
$Gd_3Ga_5O_{12}$	10	1690	[14,15]
$Y_3Al_5O_{12}$	9	2200	[16,17]
α-Al_2O_3 (ruby)	8.4 [a]	2420	[18,19]

[a] From absorption data.

Table S2. Pressure sensitivity $\frac{d\,^2E}{dp}$ for the $^2E \rightarrow ^4A_2$ transition (*R*-line), crystal field strength Dq, Racah parameter B and bulk modulus B_0 for Cr^{3+} ion in various hosts.

Compound	$\frac{d\,^2E}{dp}$ (cm^{-1}kbar^{-1})	Dq (cm^{-1})	B (cm^{-1})	B_0 (kbar)	$E(R_1)$ (cm^{-1})	Ref.
$LiCaAlF_6$	-0.33	1608	750	1000[a]	15082.96	[20,21]
$BeAl_2O_4$	-0.63	1709	675	2173	14700.26	[22,23,24]
α-Al_2O_3 (ruby)	-0.76	1800	650	2420	14404.66	[25,26,19]
$La_3Lu_2Ga_3O_{12}$	-0.8	1480	619	1330	14400	[12,27,13]
$Y_3Al_5O_{12}$	-0.8	1640	650	2200	14539.11	[28,26,17]
$Bi_2Al_4O_9$	-1.06	1667	679	1220	14173	This work, [29]
$Bi_2Ga_4O_9$	-1.14	1575	681	1020	14071	This work, [29]
$YAlO_3$	-1.33	1800	590	1920	13791.2	[28,30,31]

[a] Average value from [21].

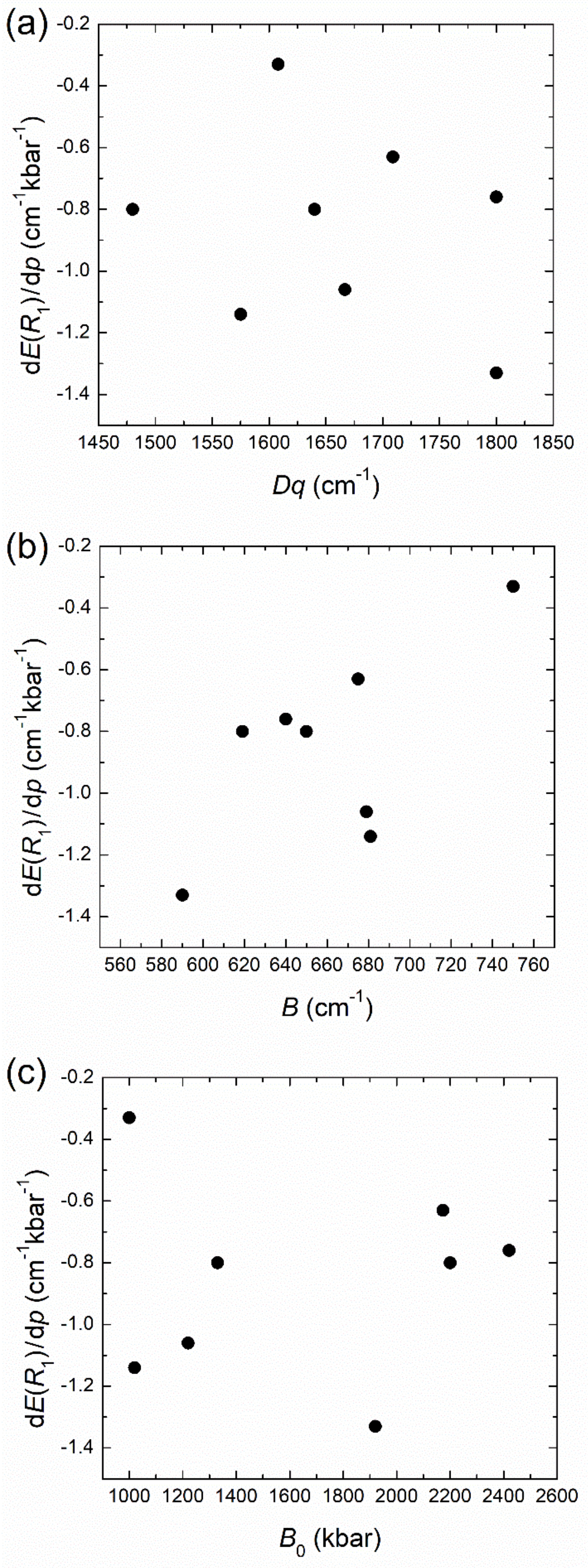

Figure S2. Pressure sensitivity $\frac{d\,^2E}{dp}$ for the $^2E \rightarrow {}^4A_2$ transition (*R*-line) as a function of the (a) crystal field strength Dq, (b) the Racah parameter B and (d) the bulk modulus B_0 for a variety of Cr^{3+}-doped crystals.

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