Supporting Information

S1. Standard formation potential of Ln-M intermetallics from trivalent Ln(III)

For Ni-richest Gd_2Ni_{17} from Gd(III), equation 1 and 2 applied

$$17Ni + 2LnF_3 + 3Be = 3BeF_2 + Ln_2Ni_{17} \tag{1}$$

$$\Delta G_{Ln_2Ni_{17}} + 3\Delta G_{BeF_2} - 2\Delta G_{LnF_3} =- 6F\Delta E_{Ln_2Ni_{17}} \tag{2}$$

$$(-18.3\times19-3\times891.9+2\times1480.1)\times1000=-6\times96485\Delta E_{Gd2Ni17}$$

$$\Delta E_{Gd2Ni17} =0.109V\ vs.\ E^0_{Be(II)/Be}$$

For Ni-richest Nd_2Ni_{17} from Nd(III) , equation 1 and 2 applied

$$(-16.9\times19-3\times891.9+2\times1464.3)\times1000=-6\times96485\Delta E_{Nd2Ni17}$$

$$\Delta E_{Nd2Ni17} =0.118V\ vs.\ E^0_{Be(II)/Be}$$

For Ni-richest $PrNi_5$ from Pr(III) , equation 3 and 4 applied

$$5Ni + PrF_3 + 1.5Be = 1.5BeF_2 + PrNi_5 \tag{3}$$

$$\Delta G_{PrNi_5} + 1.5\Delta G_{BeF_2} - \Delta G_{PrF_3} =- 3F\Delta E_{PrNi_5} \tag{4}$$

$$(-16.4\times6-1.5\times891.9+1472.7)\times1000=-3\times96485\Delta E_{PrNi5}$$

$$\Delta E_{PrNi5}=-0.126\ V\ vs.\ E^0_{Be(II)/Be}$$

For not Ni-richest $NdNi_5$ from Nd(III) , equation 5 and 6 applied

$$5Nd_2Ni_{17} + 7NdF_3 + 10.5Be = 10.5BeF_2 + 17NdNi_5 \tag{5}$$

$$17\Delta G_{NdNi_5} + 10.5\Delta G_{BeF_2} - 7\Delta G_{NdF_3} - 5\Delta G_{Nd_2Ni_{17}} =- 21F\Delta E_{NdNi_5} \tag{6}$$

$$(-28.1\times17\times6-10.5\times891.9+7\times1464.3+5\times16.9\times19)\times1000=-21\times96485\Delta E_{NdNi5}$$

$$\Delta E_{NdNi5} =0.185V\ vs.\ E^0_{Be(II)/Be}$$

For Cu-richest $PrCu_6$ from Pr(III), equation 7 and 8 applied

$$6Cu + LnF_3 + 1.5Be = LnCu_6 + 1.5BeF_2 \tag{7}$$

$$\Delta G_{LnCu_6} + 1.5\Delta G_{BeF_2} - \Delta G_{LnF_3} =- 3F\Delta E_{LnCu_6} \tag{8}$$

$$(-27.4\times7-1.5\times891.9+1472.7)\times1000=-3\times96485\Delta E_{PrCu6}$$

$$\Delta E_{PrCu6} =0.197V\ vs.\ E^0_{Be(II)/Be}$$

For Cu-richest $NdCu_6$ from Pr(III), equation 7 and 8 applied

$$(-27.6\times7-1.5\times891.9+1464.3)\times1000=-3\times96485\Delta E_{NdCu6}$$

$$\Delta E_{NdCu6}=0.231\text{V } vs.\ E^0_{Be(II)/Be}$$

For Al-richest Nd_3Al_{11} from Nd(III), equation 9 and 10 applied

$$11Al+3LnF_3+4.5Be=Ln_3Al_{11}+4.5BeF_2 \tag{9}$$

$$\Delta G_{Ln_3Al_{11}}+4.5\Delta G_{BeF_2}-3\Delta G_{LnF_3}=-9F\Delta E_{Ln_3Al_{11}} \tag{10}$$

$$(-41.3\times14-4.5\times891.9+3\times1464.3)\times1000=-9\times96485\Delta E_{Nd3Al11}$$

$$\Delta E_{Nd3Al11}=0.229\text{V } vs.\ E^0_{Be(II)/Be}$$

For Al-richest Pr_3Al_{11} from Pr(III), equation 9 and 10 applied

$$(-33.3\times14-4.5\times891.9+3\times1472.7)\times1000=-9\times96485\Delta E_{Pr3Al11}$$

$$\Delta E_{Pr3Al11}=0.071\text{V } vs.\ E^0_{Be(II)/Be}$$

For Ag-richest $Nd_{14}Ag_{51}$ from Nd(III), equation 11 and 12 applied

$$51Ag+14LnF_3+21Be=Ln_{14}Ag_{51}+21BeF_2 \tag{11}$$

$$\Delta G_{Ln_{14}Ag_{51}}+21\Delta G_{BeF_2}-14\Delta G_{LnF_3}=-42F\Delta E_{Ln_{14}Ag_{51}} \tag{12}$$

$$(-32.4\times65-21\times891.9+14\times1464.3)\times1000=-42\times96485\Delta E_{Nd14Ag51}$$

$$\Delta E_{Nd14Ag51}=0.083\text{V } vs.\ E^0_{Be(II)/Be}$$

For Ag-richest $Gd_{14}Ag_{51}$ from Gd(III), equation 11 and 12 applied

$$(-32.3\times65-21\times891.9+14\times1480.4)\times1000=-42\times96485\Delta E_{Gd14Ag51}$$

$$\Delta E_{Gd14Ag51}=0.026\text{V } vs.\ E^0_{Be(II)/Be}$$

For Ag-richest $PrAg_5$ from Pr(III), equation 13 and 14 applied

$$5Ag+PrF_3+1.5Be=PrAg_5+1.5BeF_2 \tag{13}$$

$$\Delta G_{PrAg_5}+1.5\Delta G_{BeF_2}-\Delta G_{PrF_3}=-3F\Delta E_{PrAg_5} \tag{14}$$

$$(-16.2\times6-1.5\times891.9+1472.7)\times1000=-3\times96485\Delta E_{PrAg5}$$

$$\Delta E_{PrAg5}=-0.130\text{V } vs.\ E^0_{Be(II)/Be}$$

For not Ag-richest $Pr_{14}Ag_{51}$ from Pr(III), equation 15 and 16 applied

$$51PrAg_5+19PrF_3+28.5Be=5Pr_{14}Ag_{51}+28.5BeF_2 \tag{15}$$

$$5\Delta G_{Pr_{14}Ag_{51}}+28.5\Delta G_{BeF_2}-19\Delta G_{PrF_3}-51\Delta G_{PrAg_5}=-57F\Delta E_{Pr_{14}Ag_{51}} \tag{16}$$

$$(-5\times19.4\times65-28.5\times891.9+19\times1472.7+51\times16.2\times6)\times1000=-57\times96485\Delta E_{Pr14Ag51}$$

$$\Delta E_{Pr14Ag51} = -0.221V \ vs. \ E^0_{Be(II)/Be}$$

For Au-richest $PrAu_6$ from Pr(III), equation 17 and 18 applied

$$6Au + LnF_3 + 1.5Be = LnAu_6 + 1.5BeF_2 \quad (17)$$

$$\Delta G_{LnAu_6} + 1.5\Delta G_{BeF_2} - \Delta G_{LnF_3} = -3F\Delta E_{LnAu_6} \quad (18)$$

$$(-36.6\times7-1.5\times891.9+1472.7)\times1000=-3\times96485\Delta E_{PrAu6}$$

$$\Delta E_{PrAu6} = 0.419V \ vs. \ E^0_{Be(II)/Be}$$

For Au-richest $NdAu_6$ from Nd(III), equation 17 and 18 applied

$$(-41.7\times7-1.5\times891.9+1464.3)\times1000=-3\times96485\Delta E_{NdAu6}$$

$$\Delta E_{NdAu6} = 0.572V \ vs. \ E^0_{Be(II)/Be}$$

For not Au-richest $Pr_{14}Au_{51}$ from Pr(III), equation 19 and 20 applied

$$51PrAu_6 + 33PrF_3 + 49.5Be = 6Pr_{14}Au_{51} + 49.5BeF_2 \quad (19)$$

$$6\Delta G_{Pr_{14}Au_{51}} + 49.5\Delta G_{BeF_2} - 33\Delta G_{PrF_3} - 51\Delta G_{PrAu_6} = -99F\Delta E_{Pr_{14}Au_{51}} \quad (20)$$

$$(-6\times48.5\times65-49.5\times891.9+33\times1472.7+51\times36.6\times7)\times1000=-99\times96485\Delta E_{Pr14Au51}$$

$$\Delta E_{Pr14Au51} = 0.146V \ vs. \ E^0_{Be(II)/Be}$$

For Pt-richest $NdPt_5$ from Nd(III), equation 21 and 22 applied

$$5Pt + LnF_3 + 1.5Be = LnPt_5 + 1.5BeF_2 \quad (21)$$

$$\Delta G_{LnPt_5} + 1.5\Delta G_{BeF_2} - \Delta G_{LnF_3} = -3F\Delta E_{LnPt_5} \quad (22)$$

$$(-61.8\times6-1.5\times891.9+1464.3)\times1000=-3\times96485\Delta E_{NdPt5}$$

$$\Delta E_{NdPt5} = 0.844V \ vs. \ E^0_{Be(II)/Be}$$

S2. Standard formation potential of Ln-M intermetallics from divalent Ln(II)

For Ni-richest Eu_2Ni_{17} from Eu(II) , equation 23 and 24 applied

$$17Ni + 2LnF_2 + 2Be = 2BeF_2 + Ln_2Ni_{17} \quad (23)$$

$$\Delta G_{Ln_2Ni_{17}} + 2\Delta G_{BeF_2} - 2\Delta G_{LnF_2} = -4F\Delta E_{Ln_2Ni_{17}} \quad (24)$$

$$(-13.3\times19-2\times891.9+2\times1046.1)\times1000=-4\times96485\varDelta E_{\mathrm{Eu2Ni17}}$$

$$\varDelta E_{\mathrm{Eu2Ni17}}=-0.144\text{ V } vs.\ E^{0}_{Be(II)/Be}$$

For Ni-richest Sm_2Ni_{17} from Sm(II) , equation 7 and 8 applied

$$(-18.5\times19-2\times891.9+2\times1004.4)\times1000=-4\times96485\varDelta E_{\mathrm{Sm2Ni17}}$$

$$\varDelta E_{\mathrm{Sm2Ni17}}=0.328\text{V } vs.\ E^{0}_{Be(II)/Be}$$

For not Ni-richest $EuNi_5$ from Eu(II) , equation 25 and 26 applied

$$5Ln_2Ni_{17}+7LnF_2+7Be=7BeF_2+17LnNi_5 \tag{25}$$

$$17\Delta G_{LnNi_5}+7\Delta G_{BeF_2}-5\Delta G_{Ln_2Ni_{17}}-7\Delta G_{LnF_2}=-14F\Delta E_{LnNi_5} \tag{26}$$

$$(-17\times6\times15.5-7\times891.9+5\times19\times13.3+7\times1046.1)\times1000=-14\times96485\varDelta E_{\mathrm{EuNi5}}$$

$$\varDelta E_{\mathrm{EuNi5}}=-0.564\text{ V } vs.\ E^{0}_{Be(II)/Be}$$

For Cu-richest $SmCu_6$ from Sm(II) , equation 27 and 28 applied

$$6Cu+SmF_2+Be=BeF_2+SmCu_6 \tag{27}$$

$$\Delta G_{SmCu_6}+\Delta G_{BeF_2}-\Delta G_{SmF_2}=-2F\Delta E_{SmCu_6} \tag{28}$$

$$(-19.0\times7-891.9+1004.4)\times1000=-2\times96485\varDelta E_{\mathrm{SmCu6}}$$

$$\varDelta E_{\mathrm{SmCu6}}=0.106\text{V } vs.\ E^{0}_{Be(II)/Be}$$

For Cu-richest $EuCu_5$ from Eu(II) , equation 29 and 30 applied

$$5Cu+EuF_2+Be=BeF_2+EuCu_5 \tag{29}$$

$$\Delta G_{EuCu_5}+\Delta G_{BeF_2}-\Delta G_{EuF_2}=-2F\Delta E_{EuCu_5} \tag{30}$$

$$(-22.8\times6-891.9+1046.1)\times1000=-2\times96485\varDelta E_{\mathrm{EuCu5}}$$

$$\varDelta E_{\mathrm{EuCu5}}=-0.090\text{V } vs.\ E^{0}_{Be(II)/Be}$$

For not Cu-richest $EuCu_2$ from Eu(II) , equation 31 and 32 applied

$$2EuCu_5+3EuF_2+3Be=3BeF_2+5EuCu_2 \tag{31}$$

$$5\Delta G_{EuCu_2}+3\Delta G_{BeF_2}-3\Delta G_{EuF_2}-2\Delta G_{EuCu_5}=-6F\Delta E_{EuCu_2} \tag{32}$$

$$(-5\times35.8\times3-3\times891.9+3\times1046.1+2\times22.8\times6)\times1000=-6\times96485\varDelta E_{\mathrm{EuCu2}}$$

$$\varDelta E_{\mathrm{EuCu2}}=-0.344\text{V } vs.\ E^{0}_{Be(II)/Be}$$

For Al-richest $EuAl_4$ from Eu(II) , equation 33 and 34 applied

$$4Al + LnF_2 + Be = BeF_2 + LnAl_4 \quad (33)$$

$$\Delta G_{LnAl_4} + \Delta G_{BeF_2} - \Delta G_{EuF_2} = -2F\Delta E_{LnAl_4} \quad (34)$$

$$(-24.6\times 5-891.9+1046.1)\times 1000=-2\times 96485 \Delta E_{\mathrm{EuAl4}}$$

$$\Delta E_{\mathrm{EuAl4}}=-0.162\mathrm{V}\ \textit{vs.}\ E^0_{Be(II)/Be}$$

For Al-richest $SmAl_4$ from Sm(II) , equation 33 and 34 applied

$$(-38.3\times 5-891.9+1004.4)\times 1000=-2\times 96485 \Delta E_{\mathrm{SmAl4}}$$

$$\Delta E_{\mathrm{SmAl4}}=0.409\mathrm{V}\ \textit{vs.}\ E^0_{Be(II)/Be}$$

For Ag-richest $EuAg_5$ from Eu(II) , equation 35 and 36 applied

$$5Ag + EuF_2 + Be = BeF_2 + EuAg_5 \quad (35)$$

$$\Delta G_{EuAg_5} + \Delta G_{BeF_2} - \Delta G_{EuF_2} = -2F\Delta E_{EuAg_5} \quad (36)$$

$$(-23.8\times 6-891.9+1046.1)\times 1000=-2\times 96485 \Delta E_{\mathrm{EuAg5}}$$

$$\Delta E_{\mathrm{EuAg5}}=-0.059\mathrm{V}\ \textit{vs.}\ E^0_{Be(II)/Be}$$

For Au-richest $EuAu_5$ from Eu(II) , equation 37 and 38 applied

$$5Au + EuF_2 + Be = BeF_2 + EuAu_5 \quad (37)$$

$$\Delta G_{EuAu_5} + \Delta G_{BeF_2} - \Delta G_{EuF_2} = -2F\Delta E_{EuAu_5} \quad (38)$$

$$(-43.5\times 6-891.9+1046.1)\times 1000=-2\times 96485 \Delta E_{\mathrm{EuAu5}}$$

$$\Delta E_{\mathrm{EuAu5}}=0.553\mathrm{V}\ \textit{vs.}\ E^0_{Be(II)/Be}$$

For Au-richest $SmAu_6$ from Sm(II) , equation 39 and 40 applied

$$6Au + SmF_2 + Be = BeF_2 + SmAu_6 \quad (39)$$

$$\Delta G_{SmAu_6} + \Delta G_{BeF_2} - \Delta G_{SmF_2} = -2F\Delta E_{SmAu_6} \quad (40)$$

$$(-43.3\times 7-891.9+1004.4)\times 1000=-2\times 96485 \Delta E_{\mathrm{SmAu6}}$$

$$\Delta E_{\mathrm{SmAu6}}=0.988\mathrm{V}\ \textit{vs.}\ E^0_{Be(II)/Be}$$

For Pt-richest $EuPt_5$ from Eu(II) , equation 41 and 42 applied

$$5Pt + EuF_2 + Be = BeF_2 + EuPt_5 \quad (41)$$

$$\Delta G_{EuPt_5} + \Delta G_{BeF_2} - \Delta G_{EuF_2} = -2F\Delta E_{EuPt_5} \quad (42)$$

$$(-39.3\times 6-891.9+1046.1)\times 1000=-2\times 96485 \Delta E_{\mathrm{EuPt5}}$$

$\Delta E_{\mathrm{EuPt5}}=0.423\mathrm{V}$ *vs.* $E^{0}_{Be(II)/Be}$

S3. Phase diagram of Be-M (M=W, Cu, Ni, Al, Ag, Au, Pt) binary system

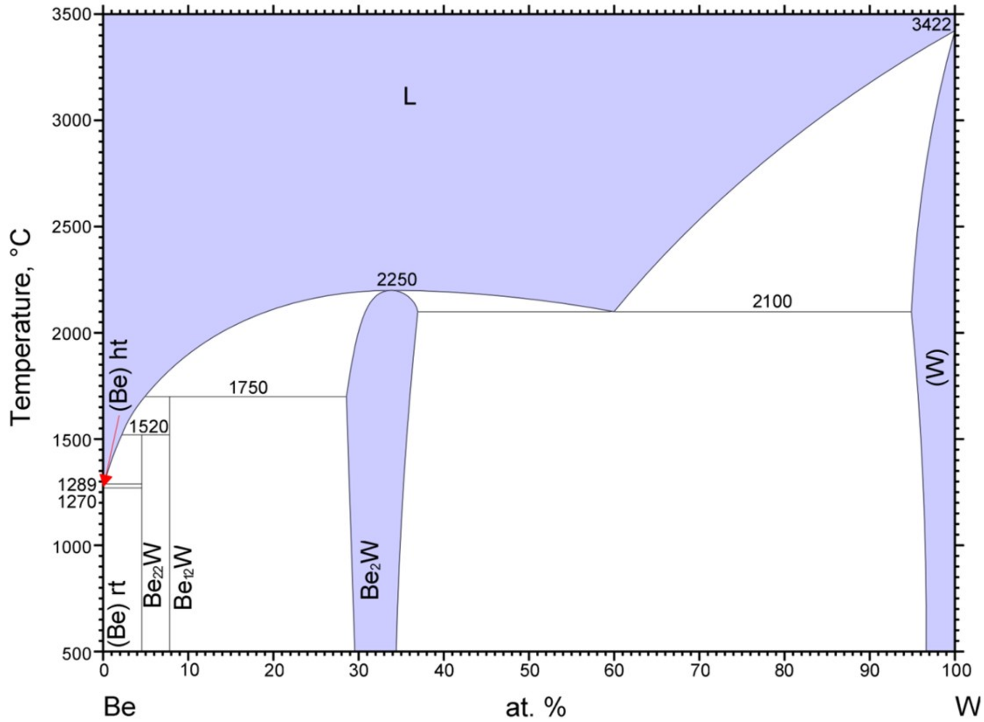

Fig. 1s. Be-W binary phase diagram [1].

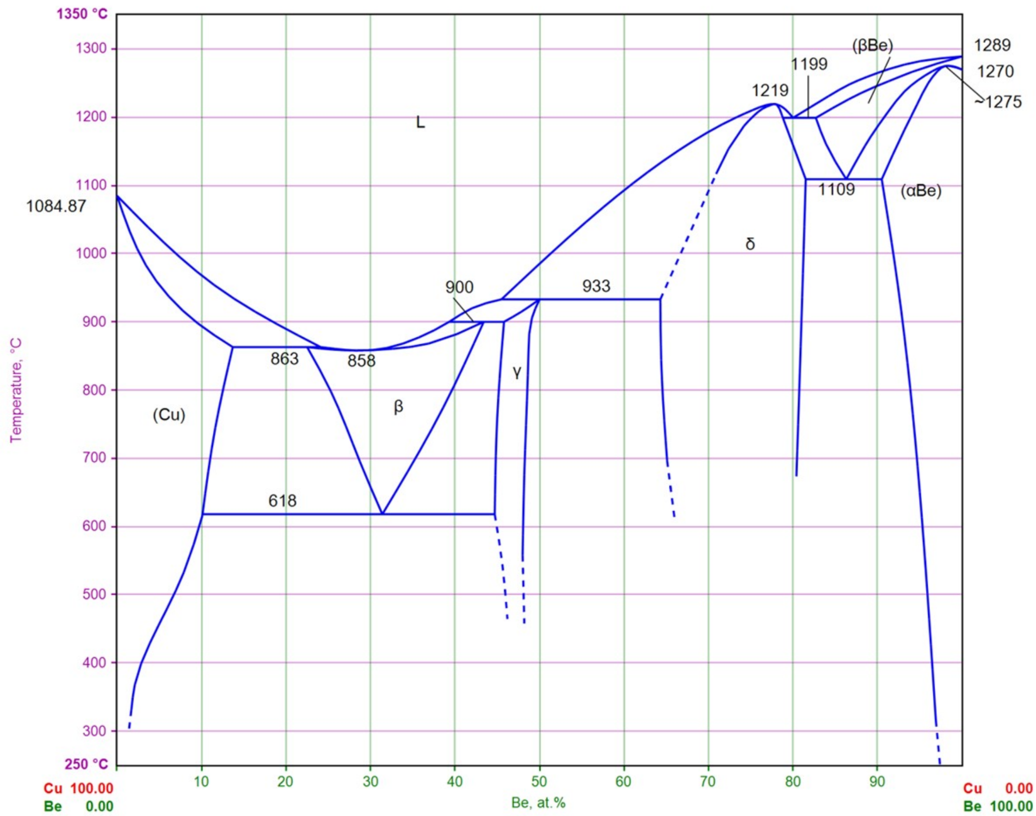

Fig. 2s. Be-Cu binary phase diagram [2].

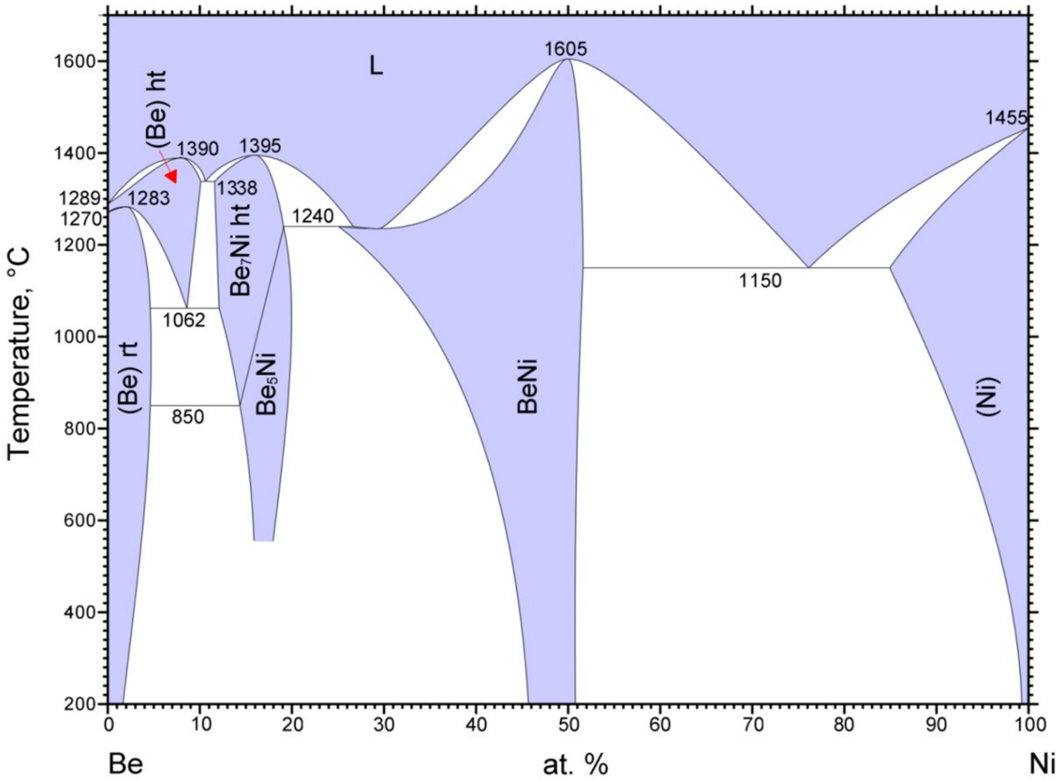

Fig. 3s. Be-Ni binary phase diagram [3].

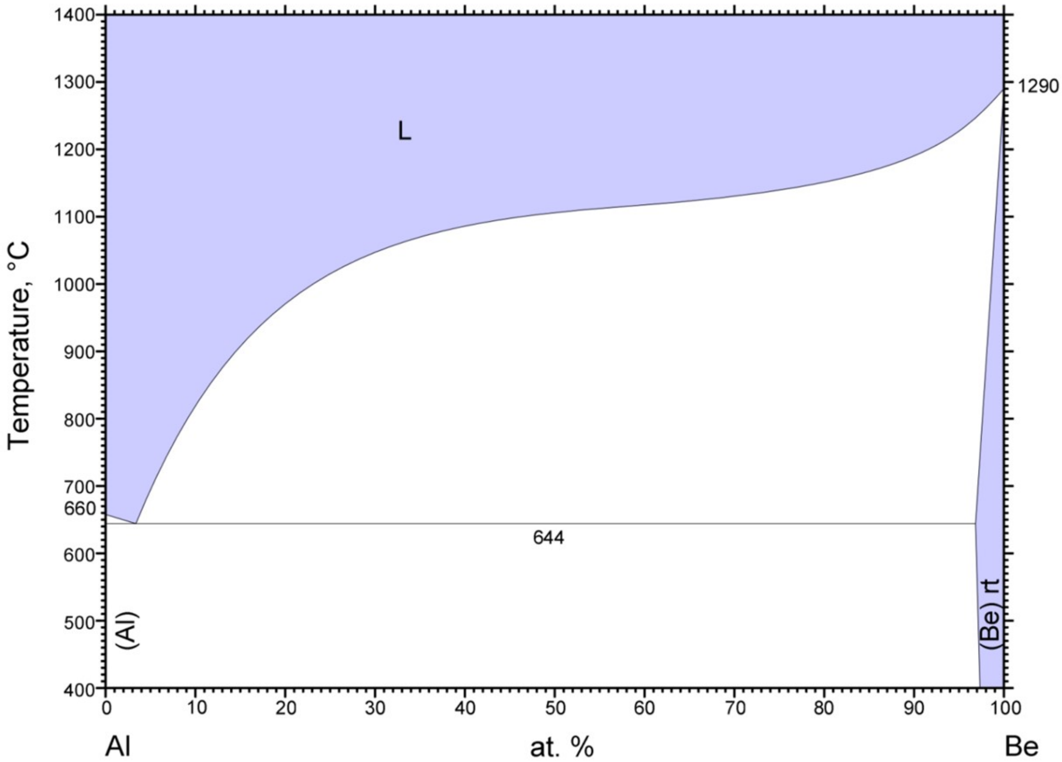

Fig. 4s. Be-Al binary phase diagram [4].

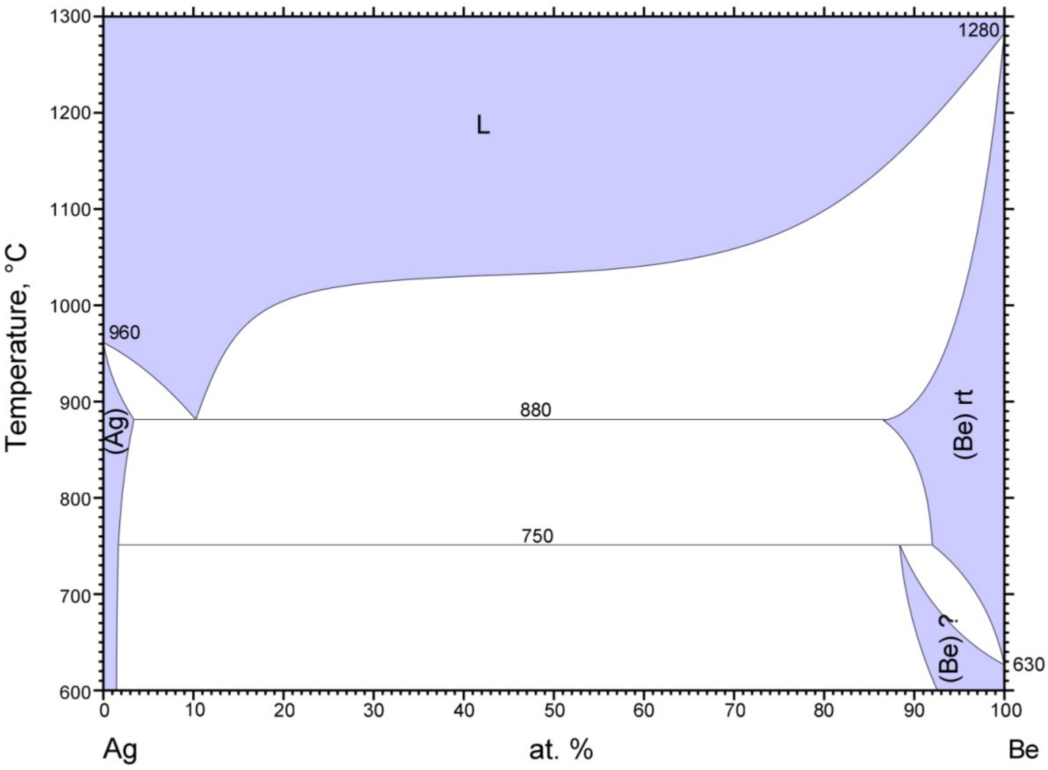

Fig. 5s. Be-Ag binary phase diagram [5].

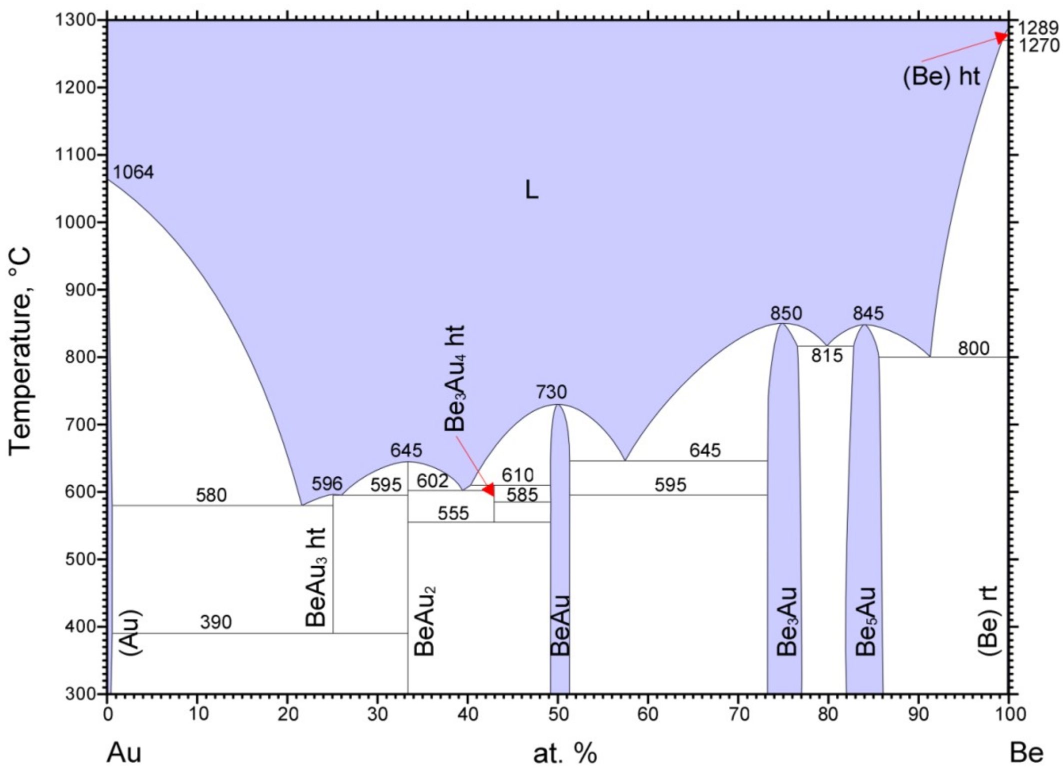

Fig. 6s. Be-Au binary phase diagram [6].

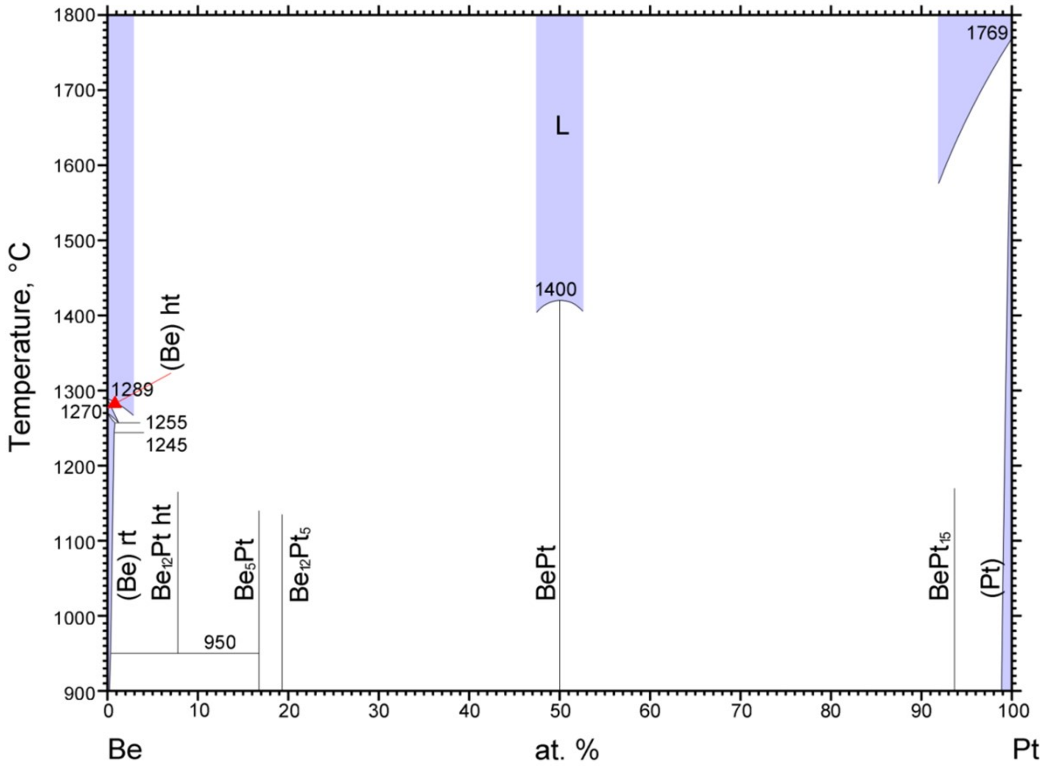

Fig. 7s. Be-Pt binary phase diagram [7].

S4. Phase diagram of Ln-W (Ln=Nd, Sm, Eu) binary system

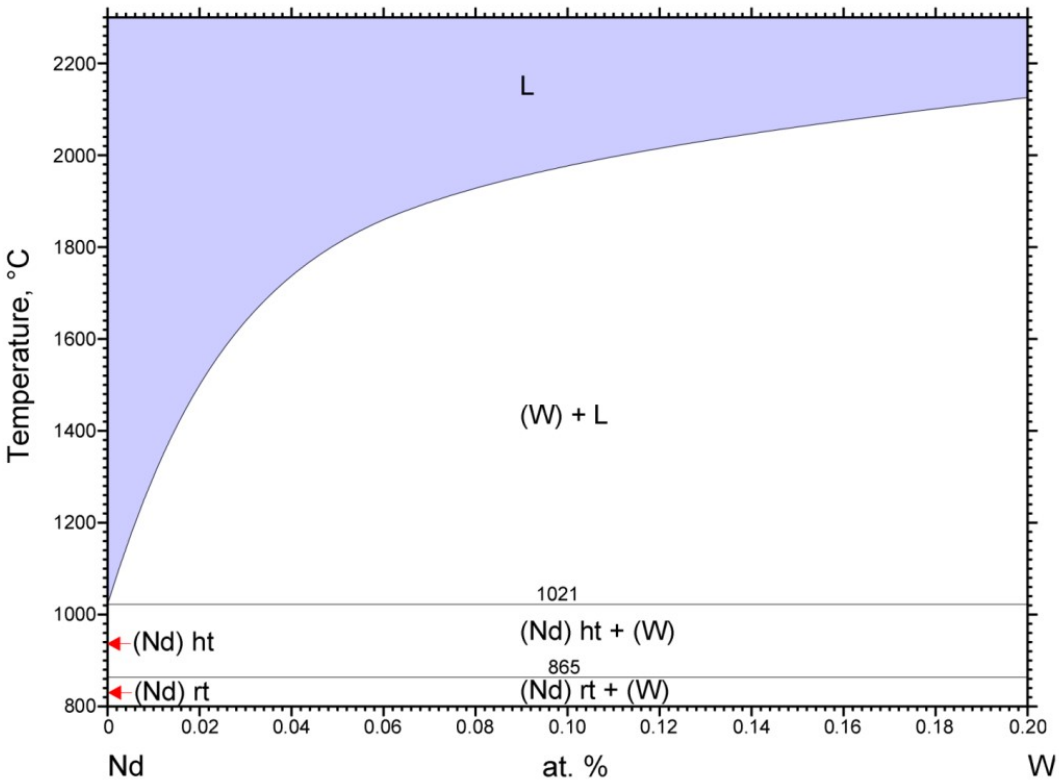

Fig. 8s. Nd-W binary phase diagram [8].

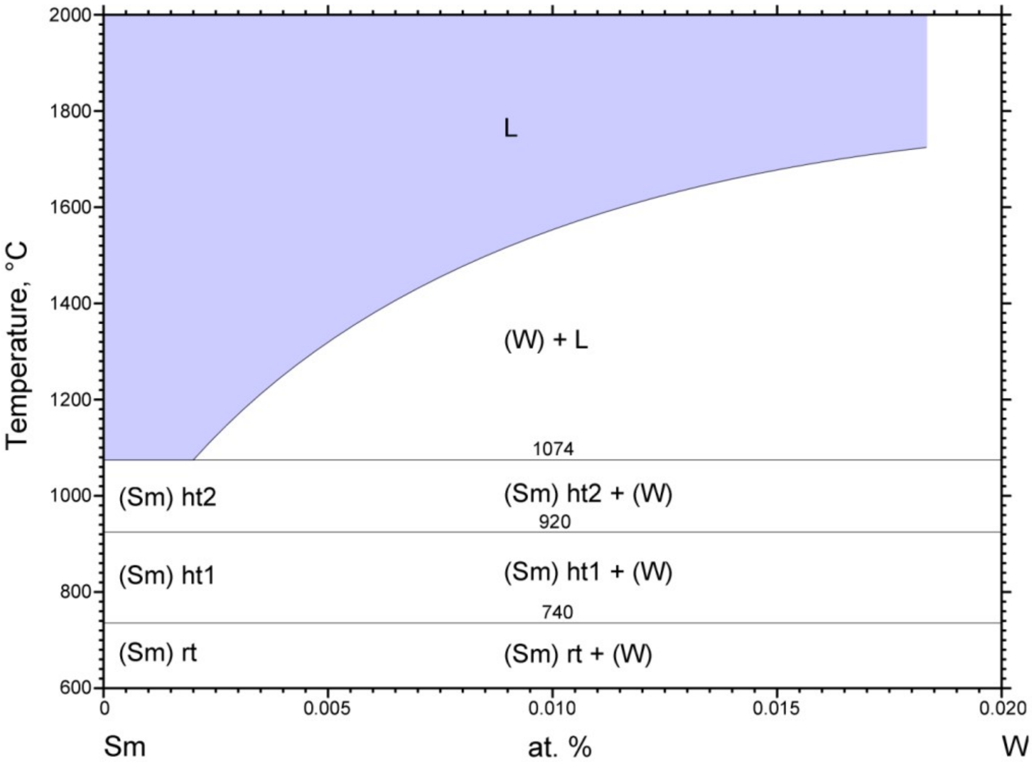

Fig. 9s. Sm-W binary phase diagram [9].

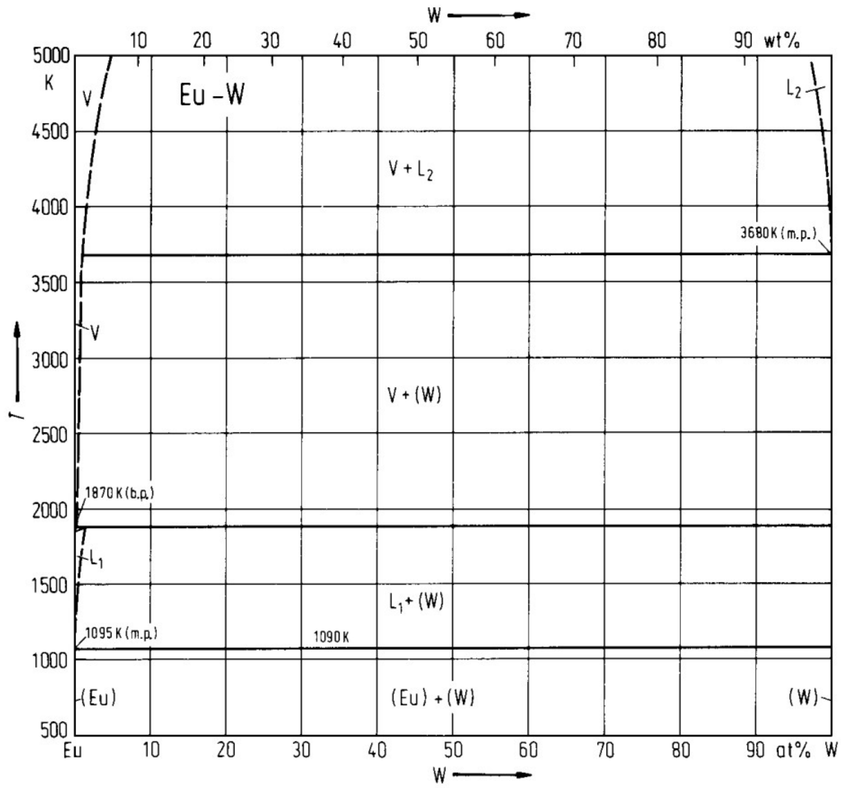

Fig. 10s Eu-W calculated phase diagram [10]

S5. XRD pattern of FLiBe-LnF_3 salts (Ln=Nd, Sm, Eu)

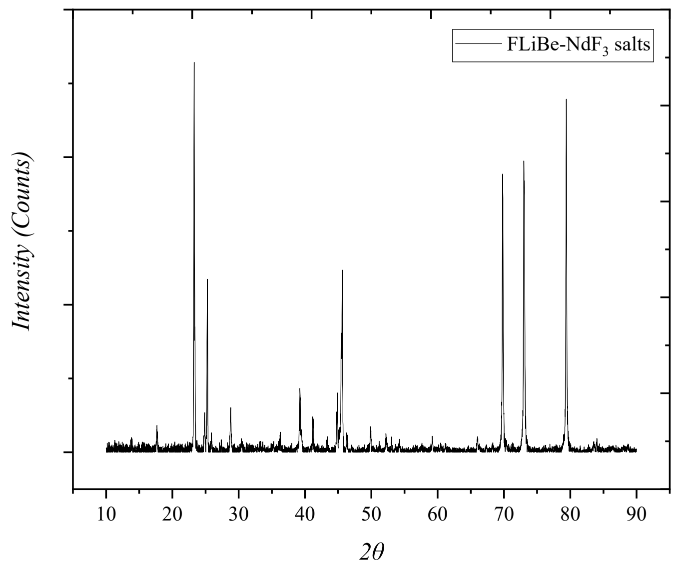

Fig.11s XRD pattern of FLiBe-2.0*wt*%NdF_3 salts

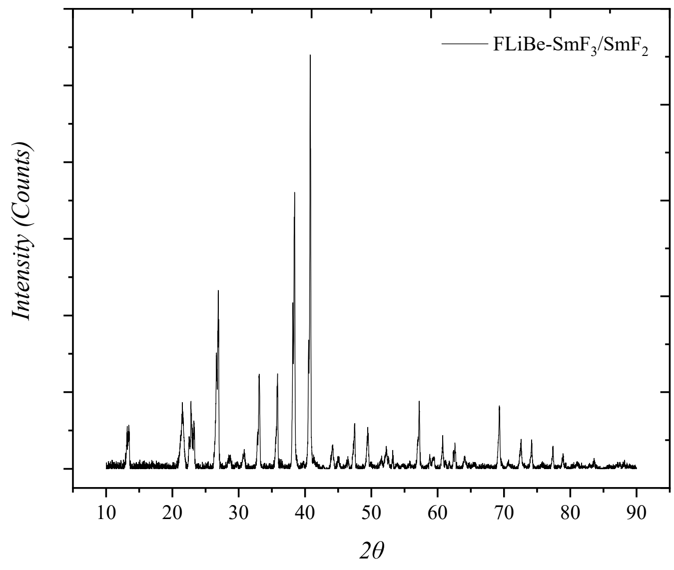

Fig.12s XRD pattern of FLiBe-2.0*wt*%SmF_3 salts

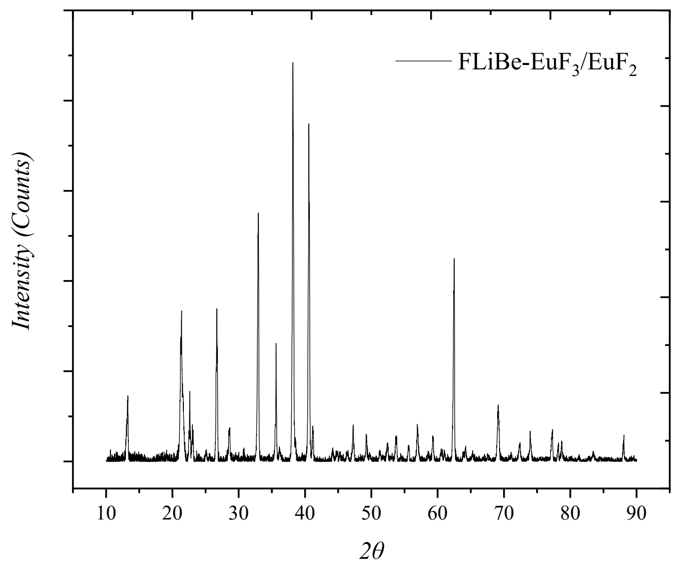

Fig.13s XRD pattern of FLiBe-1.34*wt*%EuF_3 salts

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