

Table S1: EPMA data (at%) of the as-cast and heat-treated alloy EZ2.

Condition, area in the ingot and phase	Nb	Ti	Si	Hf	Sn
As cast					
Top	44.8–46.7	23.4–25.9	16.5–21.2	5.2–5.3	4.9–5.6
	45.8 ± 0.7	24.4 ± 0.9	19.5 ± 1.8	5.3 ± 0.1	5.0 ± 0.4
Bulk	46.1–47.4	23.0–25.3	16.3–21.0	5.1–5.3	4.7–5.7
	46.5 ± 0.5	24.3 ± 0.9	18.8 ± 1.6	5.2 ± 0.1	5.2 ± 0.4
Bottom	45.8–46.0	23.0–25.3	18.0–21.3	5.1–5.3	4.8–5.6
	45.9 ± 0.1	23.5 ± 0.9	20.4 ± 1.3	5.3 ± 0.1	4.9 ± 0.4
Nb _{ss}	47.3–56.6	29.3–35.9	1.9–3.1	4.2–5.1	7.0–8.9
	53.4 ± 2.8	31.8 ± 2.2	2.4 ± 0.3	4.5 ± 0.3	7.9 ± 0.5
Ti rich Nb _{ss}	31.4–39.7	43.2–49.1	2.0–3.0	6.1–7.4	8.5–10.2
	35.9 ± 4.3	45.7 ± 3.3	2.5 ± 0.3	6.7 ± 0.5	9.2 ± 0.5
A15-Nb ₃ X (X=Si,Sn)	48.1–55.5	23.8–29.5	5.0–6.4	2.7–3.2	11.5–14.3
	50.5 ± 2.0	27.7 ± 1.6	5.6 ± 0.4	3.0 ± 0.2	13.2 ± 0.8
Nb ₅ Si ₃	42.2–44.1	13.1–17.0	34.9–37.5	3.7–5.0	1.3–1.9
	43.2 ± 0.5	14.2 ± 1.1	36.4 ± 0.5	4.6 ± 0.4	1.6 ± 0.1
Hf rich Nb ₅ Si ₃	25.5–40.3	17.8–25.8	35.6–38.5	5.4–9.5	0.8–2.3
	35.8 ± 0.6	18.8 ± 0.3	36.7 ± 0.2	6.9 ± 0.2	1.8 ± 0.1
Heat-treated - 1500 °C/100 h					
Bulk	44.1–47.0	22.0–24.6	18.0–22.2	5.1–5.7	4.5–5.6
	45.8 ± 0.8	23.6 ± 0.8	20.3 ± 1.4	5.3 ± 0.2	5.0 ± 0.3
Nb _{ss}	56.5–60.3	29.6–32.2	1.1–1.6	3.7–4.2	4.7–6.0
	58.3 ± 0.9	31.1 ± 0.7	1.3 ± 0.1	4.0 ± 0.1	5.3 ± 0.3
A15-Nb ₃ X (X=Si,Sn)	4.8–6–51.0	27.7–30.2	4.1–4.9	2.6–3.1	13.8–14.6
	49.5 ± 0.7	29.0 ± 0.7	4.5 ± 0.2	2.8 ± 0.1	14.2 ± 0.2
Nb ₅ Si ₃	37.4–43.5	13.3–17.3	36.3–37.2	3.9–6.3	1.4–1.9
	41.5 ± 2.0	14.9 ± 1.4	36.9 ± 0.3	5.1 ± 0.6	1.6 ± 0.2
Hf rich Nb ₅ Si ₃	24.0–25.3	24.4–25.7	38.9–39.6	10.3–11.3	0.3–0.6
	24.6 ± 0.3	25.0 ± 0.3	39.2 ± 0.2	10.8 ± 0.2	0.4 ± 0.1

Table S2: EPMA data (at%) of the as-cast and heat-treated alloy EZ5.

Condition, area in the ingot and phase	Nb	Ti	Si	Al	Hf	Sn
As cast						
Top	41.5–41.9 41.6 ± 0.1	23.5–23.7 23.6 ± 0.1	20.0–21.0 20.2 ± 0.2	4.7–4.8 4.7 ± 0.1	4.9–5.1 5 ± 0.1	4.9–5.0 4.9 ± 0.1
Bulk	41.6–42.7 42.0 ± 0.3	23.6–24.6 24.2 ± 0.2	17.3–20.1 18.8 ± 0.3	4.5–5.0 4.8 ± 0.1	5.0–5.4 5.2 ± 0.1	4.6–5.6 5 ± 0.1
Bottom	42.3–42.6 42.4 ± 0.1	23.4–24.7 24 ± 0.2	17.5–20.2 18.8 ± 0.4	4.4–5.1 4.7 ± 0.1	4.9–5.5 5.2 ± 0.1	4.7–5.2 4.9 ± 0.1
Nb _{ss}	39.7–51.2 46.0 ± 2.1	29.5–37.7 33.9 ± 1.1	1.4–6.6 2.5 ± 0.9	5.4–7.2 6.2 ± 0.4	3.6–7.1 5.2 ± 0.6	3.6–10.2 6.2 ± 1.0
A15-Nb ₃ X (X=Al,Si,Sn)	49.3–55.6 53.3 ± 0.8	21.2–26.9 23.6 ± 0.6	3.8–5.6 4.4 ± 0.3	4.4–5.9 5.3 ± 0.3	2.2–3.5 2.7 ± 0.4	9.1–11.5 10.7 ± 0.5
Nb ₅ Si ₃	37.1–43.9 41.0 ± 0.7	16.1–21.4 17.5 ± 0.9	29.7–33.3 31.4 ± 0.7	2.3–4.7 3.5 ± 0.6	3.5–4.6 4.1 ± 0.3	1.5–3.4 2.5 ± 0.5
Ti & Hf rich Nb ₅ Si ₃	25.6–39.1 31.4 ± 1.4	20.0–26.7 23.1 ± 0.5	28.9–34.2 32.1 ± 0.6	3.6–4.7 3.5 ± 0.1	4.6–10.5 8.5 ± 0.5	0.7–4.1 1.4 ± 0.7
Nb _{ss} -Ti & Hf rich Nb ₅ Si ₃ Eu-tectic	37.1–40.3 38.9 ± 0.4	29.9–31.3 30.6 ± 0.2	11.1–15.3 13.4 ± 0.6	5.2–5.7 5.4 ± 0.1	6.7–8.0 7.3 ± 0.2	3.9–5.0 4.4 ± 0.3
Heat-treated - 1500 °C/100 h (EZ5-HT1)						
Bulk	41.5–43.5 42.5 ± 0.3	24.0–24.5 24.3 ± 0.1	17.3–19.2 18.3 ± 0.4	4.4–4.8 4.6 ± 0.1	5.1–5.8 5.4 ± 0.1	4.6–5.3 4.9 ± 0.1
A15-Nb ₃ X (X=Al,Si,Sn)	51.4–54.2 52.6 ± 0.4	24.6–26.8 25.6 ± 0.4	3.9–4.9 4.5 ± 0.3	5.9–6.6 6.2 ± 0.1	1.6–2.6 2.1 ± 0.2	8.5–9.4 9.0 ± 0.2
Nb ₅ Si ₃	38.4–40.9 39.1 ± 0.4	16.9–18.5 17.4 ± 0.3	33.7–35.6 34.9 ± 0.3	1.9–2.3 2.1 ± 0.1	4.1–6.0 5.3 ± 0.3	1.0–1.6 1.2 ± 0.2
Ti & Hf rich Nb ₅ Si ₃	24.7–27.2 26.0 ± 0.5	23.7–25.2 24.6 ± 0.4	34.2–35.9 35.4 ± 0.4	2.9–3.7 3.4 ± 0.2	9.4–11.3 10.1 ± 0.4	0.3–0.8 0.5 ± 0.1
Heat-treated - 1500 °C/200 h (EZ5-HT2)						
Bulk	41.6–42.1 41.9 ± 0.1	24.1–24.5 24.3 ± 0.1	18.2–18.7 18.4 ± 0.1	4.6–4.3 5.0 ± 0.1	5.2–5.5 5.4 ± 0.1	5.0–5.1 5.0 ± 0.0
A15-Nb ₃ Sn (X=Al,Si,Sn)	50.9–53.4 52.2 ± 0.8	25.5–26.0 25.8 ± 0.1	3.4–5.3 4.4 ± 0.5	5.9–7.0 6.2 ± 0.2	2.0–2.9 2.4 ± 0.3	8.6–9.5 9.0 ± 0.2
Nb ₅ Si ₃	38.0–38.9 38.7 ± 0.3	17.4–18.7 17.9 ± 0.4	32.8–34.3 33.6 ± 0.5	2.3–3.5 2.8 ± 0.4	5.3–6.1 5.7 ± 0.2	1.1–1.5 1.3 ± 0.1
Ti & Hf rich Nb ₅ Si ₃	26.4–27.7 27.1 ± 0.4	24.4–25.0 24.8 ± 0.2	34.1–35.3 34.6 ± 0.3	3.0–3.8 3.4 ± 0.2	9.5–9.8 9.7 ± 0.1	0.0–0.8 0.4 ± 0.2

Table S3: EPMA data (at%) of the as-cast and heat-treated alloy EZ6.

Condition, area in the ingot and phase	Nb	Ti	Si	Cr	Hf	Sn
As cast *						
Top	41.3–42.0 41.5 ± 0.3	22.7–24.5 23.5 ± 0.5	18.9–21.8 20.6 ± 0.5	3.8–5.0 4.4 ± 0.3	5.1–5.3 5.2 ± 0.0	4.5–5.0 4.8 ± 0.1
Bulk	40.8–42.3 41.4 ± 0.4	22.9–25.4 24.1 ± 0.5	17.7–21.4 19.6 ± 0.6	3.9–5.5 4.7 ± 0.3	5.0–5.5 5.2 ± 0.1	4.8–5.4 5.0 ± 0.2
Bottom	37.0–41.5 40.3 ± 0.4	22.5–29.3 24.9 ± 0.7	14.8–21.7 18.9 ± 0.9	4.3–7.6 5.3 ± 0.5	5.2–6.3 5.5 ± 0.3	4.9–5.2 5.1 ± 0.1
Nb _{ss}	46.9–56.1 50.5 ± 0.5	26.8–31.9 29.8 ± 0.6	1.5–2.4 1.9 ± 0.2	4.9–8.9 7.2 ± 0.4	3.4–4.6 3.9 ± 0.2	6.3–7.3 6.7 ± 0.2
Ti-rich Nb _{ss}	35.2–47.4 42.0 ± 0.8	31.7–42.4 35.0 ± 0.9	1.2–2.5 1.7 ± 0.3	7.8–12.0 10.0 ± 0.3	3.5–5.3 4.2 ± 0.3	6.0–8.5 7.1 ± 0.4
A15-Nb ₃ X (X=Si,Sn)	50.4–55.4 53.4 ± 0.2	22.0–25.2 23.0 ± 0.6	5.1–5.8 5.4 ± 0.2	1.9–3.4 2.6 ± 0.4	2.1–2.6 2.4 ± 0.1	12.9–13.7 13.2 ± 0.2
Nb ₅ Si ₃	40.8–42.8 41.7 ± 0.3	14.1–17.3 14.8 ± 0.4	33.9–36.7 36.0 ± 0.5	0.0–2.0 0.9 ± 0.2	3.8–5.0 4.8 ± 0.2	1.4–2.2 1.8 ± 0.1
Ti & Hf-rich Nb ₅ Si ₃	22.7–38.5 29.2 ± 1.1	16.2–26.6 22.7 ± 0.8	31.4–38.6 37.0 ± 0.6	0.0–2.4 1.0 ± 0.5	6.2–10.5 8.9 ± 0.6	0.0–2.6 1.2 ± 0.6
Cr-rich C14 Laves phase	15.8–22.6 19.1 ± 1.2	14.9–26.8 18.3 ± 0.7	6.8–13.0 9.8 ± 0.7	34.4–48.7 44.8 ± 0.8	5.6–8.2 7.0 ± 0.6	0.0–3.4 1.0 ± 0.8
Heat-treated - 1500 °C/100 h (EZ6-HT1)						
Bulk	41.3–42.7 42.2 ± 0.3	22.1–24.2 23.2 ± 0.4	19.2–21.3 20.3 ± 0.3	3.5–4.8 4.2 ± 0.2	4.9–5.4 5.1 ± 0.1	4.4–5.6 5.0 ± 0.2
Nb _{ss}	49.7–50.5 50.1 ± 0.2	31.3–33.6 32.4 ± 0.4	0.8–1.0 0.9 ± 0.1	5.8–8.5 7.2 ± 0.3	2.8–3.2 3.0 ± 0.1	6.2–6.6 6.4 ± 0.1
A15-Nb ₃ X (X=Si,Sn)	47.5–47.9 47.7 ± 0.1	26.5–27.7 26.9 ± 0.2	3.8–4.6 4.3 ± 0.2	4.4–4.7 4.6 ± 0.1	2.3–2.4 2.3 ± 0.0	14.0–14.3 14.2 ± 0.1
Nb ₅ Si ₃	38.9–42.5 40.7 ± 0.4	14.1–17.1 15.6 ± 0.2	36.4–36.6 36.5 ± 0.1	0.3	4.9–5.7 5.3 ± 0.1	1.6–1.6 1.6 ± 0.0
Ti & Hf-rich Nb ₅ Si ₃	25.4–25.7 25.5 ± 0.1	24.1–24.3 24.2 ± 0.1	38.2–38.3 38.2 ± 0.1	1.0–1.0 1.0 ± 0.0	10.4–10.5 10.5 ± 0.0	0.4–0.7 0.6 ± 0.1
Cr-rich C14 Laves phase	27.1–30.1 28.1 ± 0.4	14.2–14.7 14.4 ± 0.1	5.4–5.7 5.6 ± 0.1	43.4–44.4 44.7 ± 0.1	4.2–4.5 4.4 ± 0.1	2.0–3.4 2.8 ± 0.3
Heat-treated - 1200 °C/100 h (EZ6-HT2)						
Bulk	40.2–42.4 41.7 ± 0.5	23.3–24.5 23.8 ± 0.3	17.9–21.0 19.3 ± 0.7	3.7–5.7 4.7 ± 0.4	5.1–5.6 5.4 ± 0.3	4.7–5.7 5.1 ± 0.4
Nb _{ss}	53.5–57.2 55.2 ± 0.5	28.9–31.6 30.7 ± 0.6	0.0–0.9 0.6 ± 0.2	5.9–8.2 7.2 ± 0.5	2.2–2.5 2.3 ± 0.1	3.5–4.6 4.0 ± 0.3
A15-Nb ₃ X (X=Si,Sn)	44.7–47.1 45.7 ± 0.5	30.2–31.7 30.9 ± 0.5	2.4–4.1 3.0 ± 0.4	2.7–3.7 3.2 ± 0.3	1.8–2.5 2.0 ± 0.2	14.2–15.9 15.2 ± 0.3
Nb ₅ Si ₃	41.9–44.9 42.5 ± 0.6	13.6–17.1 14.5 ± 0.5	30.2–36.9 35.5 ± 0.6	0.0–1.0 0.6 ± 0.2	4.7–5.2 5.0 ± 0.1	1.5–2.3 1.9 ± 0.2
Ti & Hf-rich Nb ₅ Si ₃	18.2–26.0 21.8 ± 0.5	25.3–27.8 26.4 ± 0.4	31.5–40.0 37.3 ± 0.7	0.5–1.4 0.8 ± 0.3	10.4–14.7 12.7 ± 0.8	0.0–3.4 1.0 ± 0.7
Cr-rich C14 Laves phase	21.4–23.8 21.9 ± 0.4	11.4–13.5 12.2 ± 0.4	8.0–13.3 9.6 ± 0.6	44.4–52.9 49.7 ± 0.6	5.2–6.9 5.8 ± 0.3	0.0–1.2 0.8 ± 0.2

* For the Nb_{ss}+NbCr₂ eutectic see text

Table S4: EPMA data (at%) of the as-cast and heat-treated alloy EZ8.

Condition, area in the ingot and phase	Nb	Ti	Si	Al	Cr	Hf	Sn
As cast							
Top	36.9–37.5 37.1 ± 0.1	23.5–24.3 23.8 ± 0.2	19.0–21.0 20.0 ± 0.3	4.4–4.7 4.6 ± 0.1	4.2–4.8 4.4 ± 0.2	5.1–5.4 5.2 ± 0.1	4.9–5.0 4.9 ± 0.0
Bulk	36.9–38.0 37.2 ± 0.3	23.6–24.3 24.1 ± 0.2	17.9–19.7 18.8 ± 0.4	4.6–5.0 4.8 ± 0.1	4.3–5.6 4.7 ± 0.2	5.1–5.3 5.2 ± 0.0	4.7–5.3 5.2 ± 0.1
Bottom	35.5–37.0 36.3 ± 0.3	24.3–26.4 25.9 ± 0.4	13.3–17.9 14.7 ± 0.7	5.0–5.5 5.4 ± 0.1	5.6–6.5 6.1 ± 0.2	5.1–6.2 5.7 ± 0.2	5.1–6.1 5.9 ± 0.2
Nb _{ss}	30.7–37.2 35.9 ± 0.5	34.2–37.9 36.4 ± 0.4	0.9–6.0 1.7 ± 0.8	5.9–7.4 6.7 ± 0.4	9.2–14.4 10.9 ± 0.7	2.9–5.0 3.7 ± 0.6	3.8–5.6 4.7 ± 0.4
A15-Nb ₃ X X=Al,Si,Sn	42.1–51.9 48.0 ± 0.9	22.1–27.1 25.0 ± 0.5	3.6–7.7 4.3 ± 0.7	4.7–6.8 5.5 ± 0.5	2.1–5.5 3.6 ± 0.6	2.0–3.4 2.5 ± 0.4	8.8–12.3 11.1 ± 0.8
Nb ₅ Si ₃	35.7–40.5 38.9 ± 0.9	17.1–20.5 18.2 ± 0.5	28.4–33.7 30.4 ± 0.5	2.0–4.5 3.7 ± 0.6	0.4–2.3 1.2 ± 0.2	4.0–5.3 4.5 ± 0.3	1.7–4.2 3.1 ± 0.5
Ti & Hf-rich Nb ₅ Si ₃	23.2–29.3 25.8 ± 0.6	22.0–26.2 24.6 ± 0.4	23.4–34.6 32.0 ± 0.8	3.5–5.2 4.1 ± 0.4	0.7–4.6 1.8 ± 0.6	9.4–11.7 10.3 ± 0.5	0.5–2.9 1.4 ± 0.6
NbCr ₂ - Nb _{ss} Eutectic	20.4–26.7 23.2 ± 0.5	14.3–26.5 21.7 ± 0.9	4.8–10.3 7.0 ± 0.6	3.1–5.2 4.4 ± 0.3	29.2–45.5 35.8 ± 1.1	4.9–6.7 6.0 ± 0.4	0.5–2.8 1.9 ± 0.4
NbCr ₂ Laves	19.0–19.8 19.4 ± 0.2	14.0–15.1 14.6 ± 0.2	9.1–10.8 10.3 ± 0.2	3.1–3.6 3.4 ± 0.1	44.3–47.0 45.6 ± 0.5	6.0–6.7 6.4 ± 0.1	0.3
Heat-treated - 1300 °C/100 h							
Bulk	37.7–39.2 38.1 ± 0.2	22.6–24.2 23.6 ± 0.4	17.7–20.3 19.1 ± 0.3	4.3–4.8 4.5 ± 0.1	3.8–6.8 4.7 ± 0.4	4.9–5.4 5.3 ± 0.1	4.3–5.0 4.7 ± 0.1
A15-Nb ₃ X X=Al,Si,Sn	46.8–47.9 47.4 ± 0.2	26.3–27.1 26.7 ± 0.2	2.9–4.1 3.2 ± 0.2	6.3–6.7 6.5 ± 0.1	4.3–4.8 4.6 ± 0.1	1.4–1.9 1.6 ± 0.1	9.6–10.2 10.0 ± 0.1
Nb ₅ Si ₃	40.0–41.6 41.1 ± 0.2	17.0–18.6 17.5 ± 0.3	31.1–33.1 32.3 ± 0.2	2.2–2.9 2.5 ± 0.1	0.4–1.0 0.6 ± 0.2	3.9–4.6 4.1 ± 0.1	1.7–2.1 1.9 ± 0.1
Ti&Hf-rich Nb ₅ Si ₃	22.8–25.8 24.4 ± 0.4	24.7–26.2 25.6 ± 0.3	31.5–34.1 33.3 ± 0.3	3.7–5.0 4.0 ± 0.2	0.9–2.1 1.3 ± 0.3	9.7–12.6 10.6 ± 0.4	0.5–1.2 0.8 ± 0.2
NbCr ₂ Laves phase	22.3–22.6 22.4 ± 0.1	10.4–11.0 10.7 ± 0.1	9.1–9.6 9.3 ± 0.1	2.6–2.9 2.7 ± 0.1	49.5–50.3 50.0 ± 0.2	4.8–5.0 4.9 ± 0.0	–

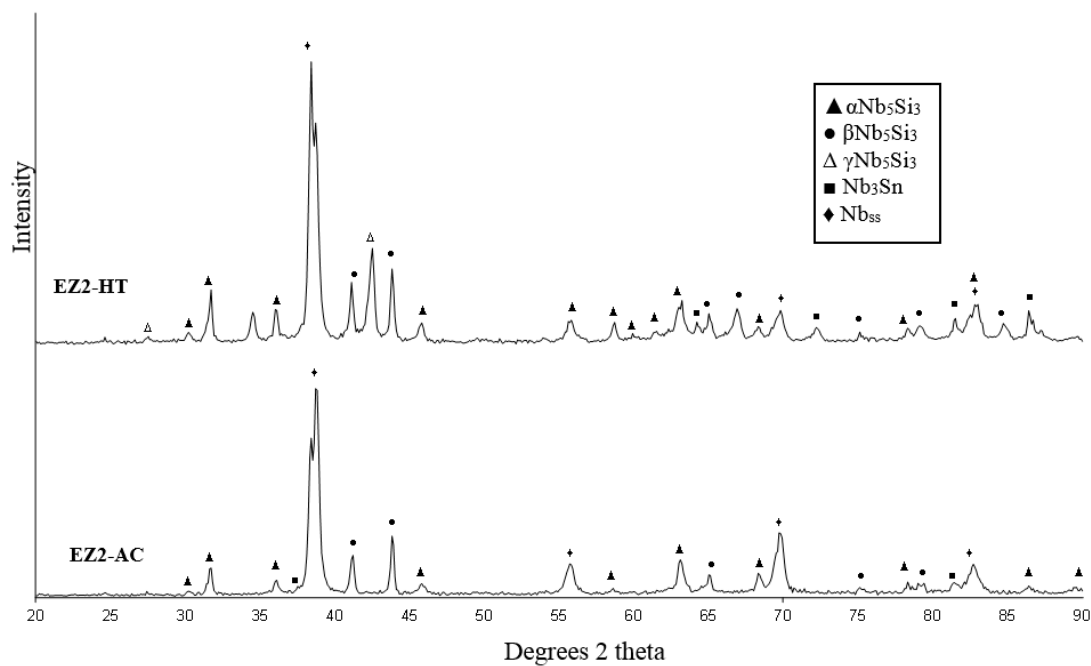


Figure S1: X-ray diffractograms of the as-cast and heat-treated alloy EZ2.

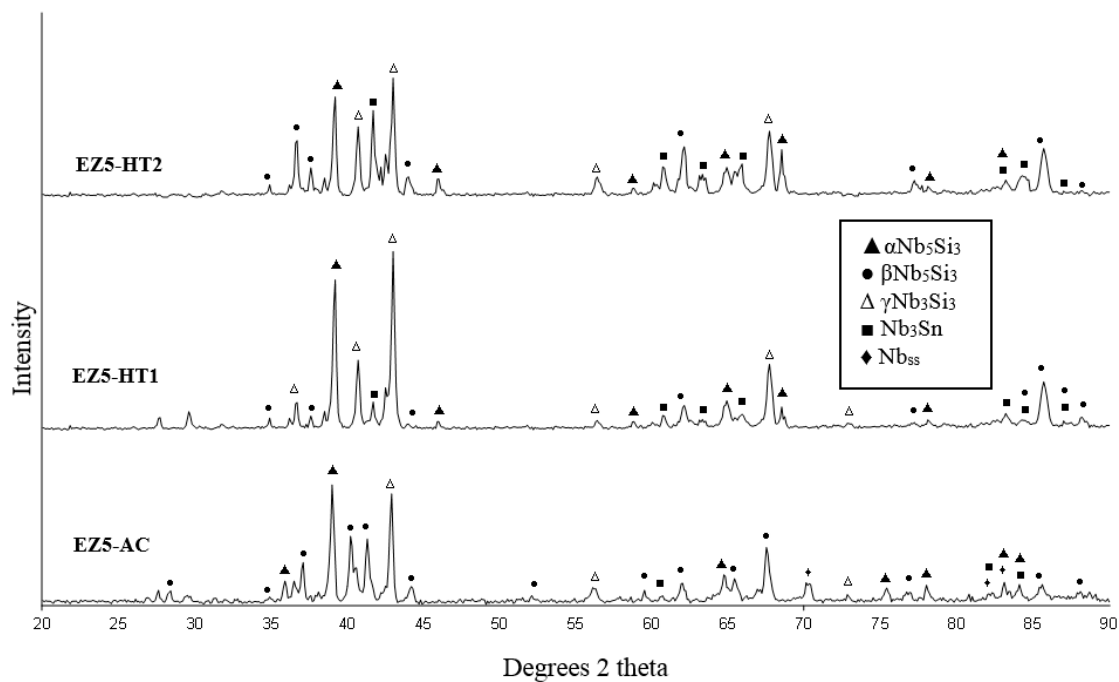


Figure S2: X-ray diffractograms of the as-cast and heat-treated alloy EZ5.

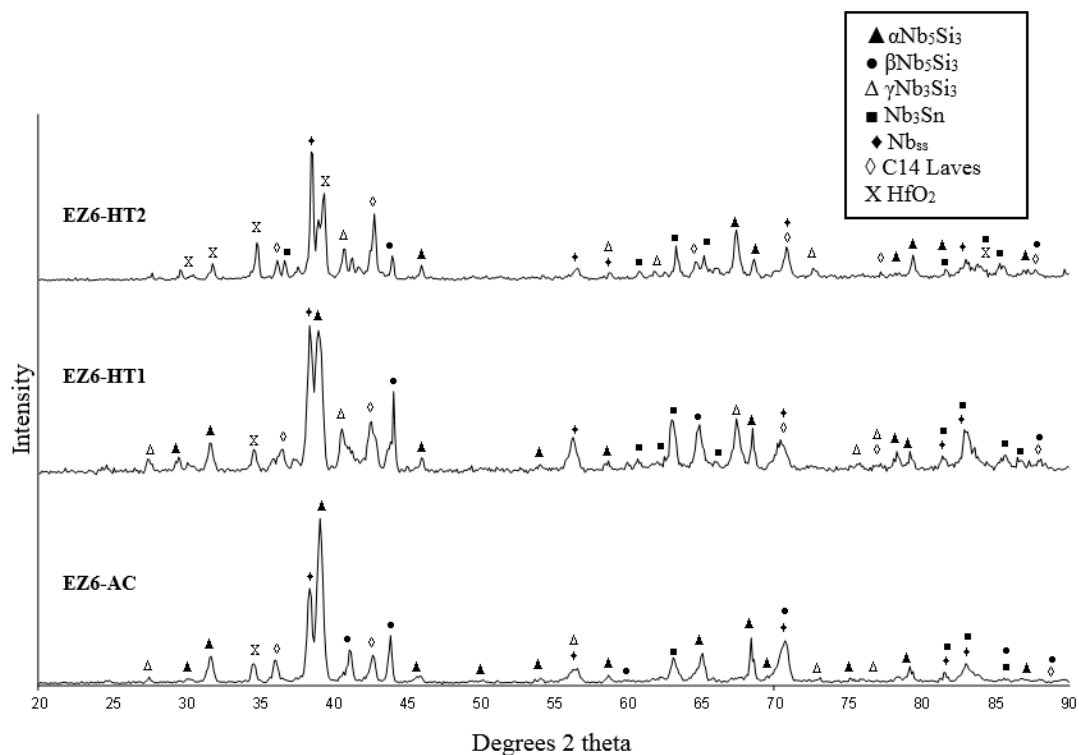


Figure S3: X-ray diffractograms of the as-cast and heat-treated alloy EZ6.

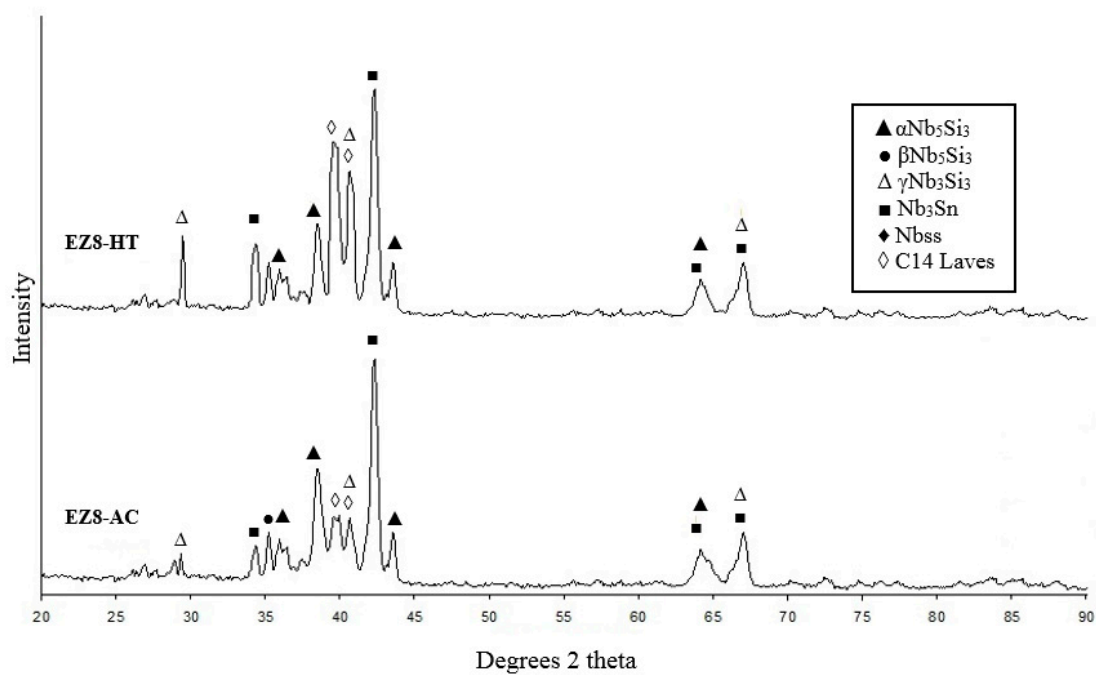


Figure S4: X-ray diffractograms of the as-cast and heat-treated alloy EZ8.