

Università degli Studi di Padova – *Dipartimento di Ingegneria Industriale*

Corso di Laurea in *Ingegneria Meccanica*

Relazione per la Prova Finale

**«Componenti bimetallici ottenuti
mediante tecniche additive»**

Laureando: *Federico Caroppo*, 1216796

Tutor universitario: *Professor Paolo Ferro*

Tutor universitario: *Professor Gianpaolo Savio*



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Componenti bimetallici

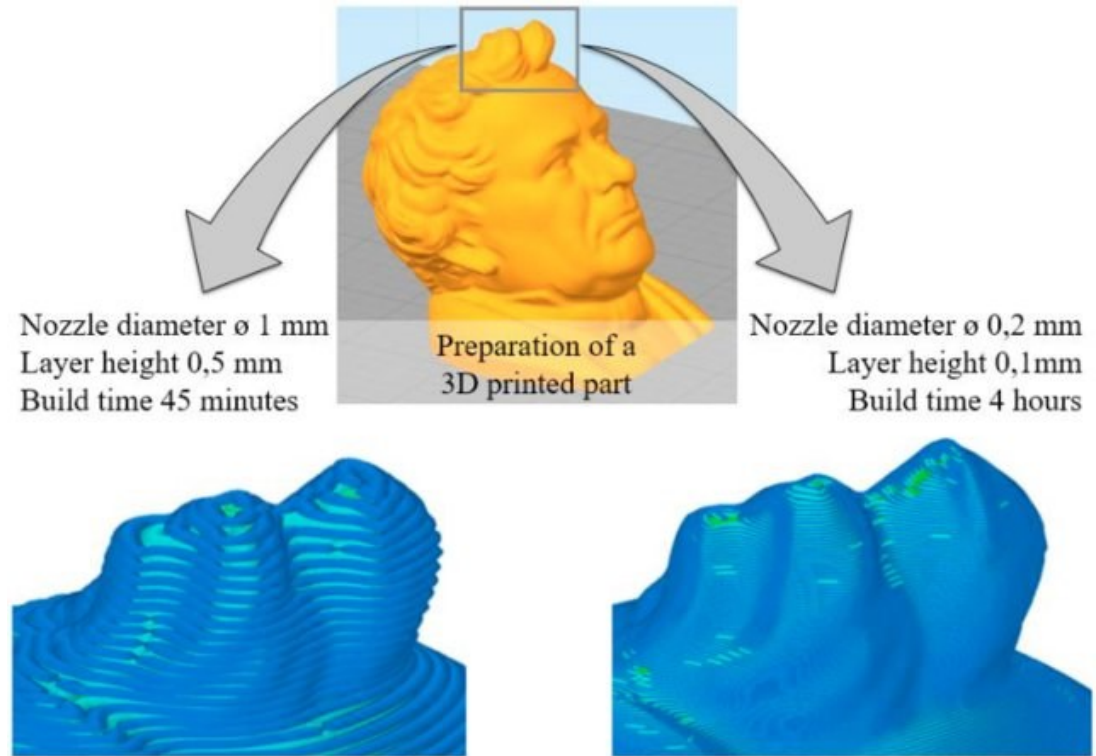
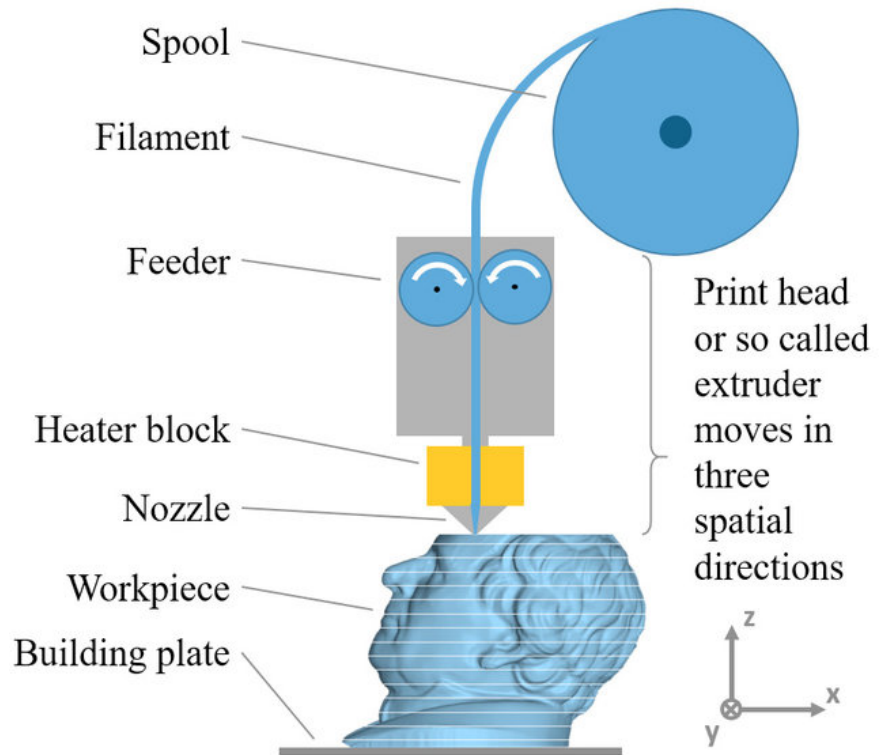


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Federico Caroppo - A.A. 2021/2022

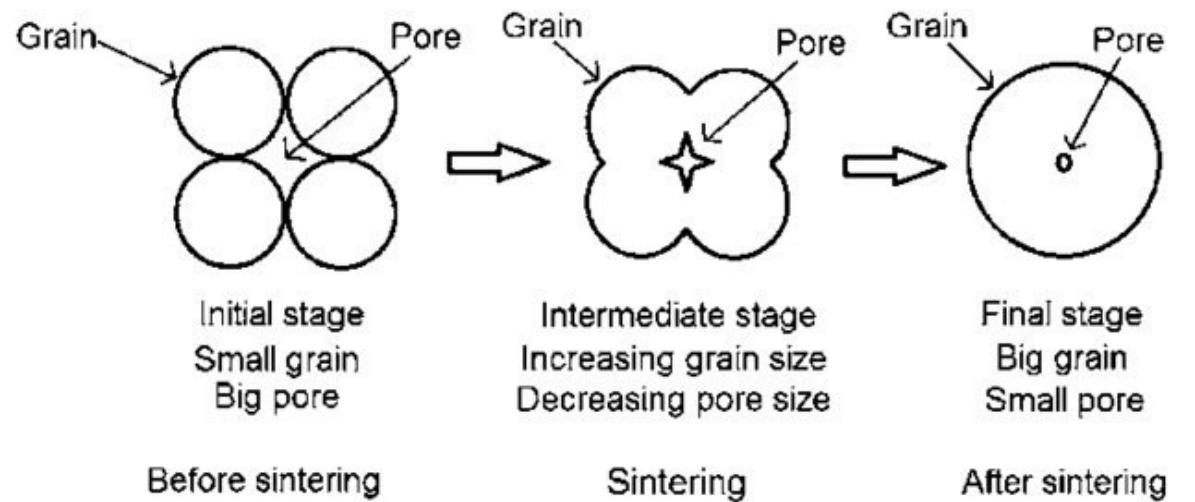
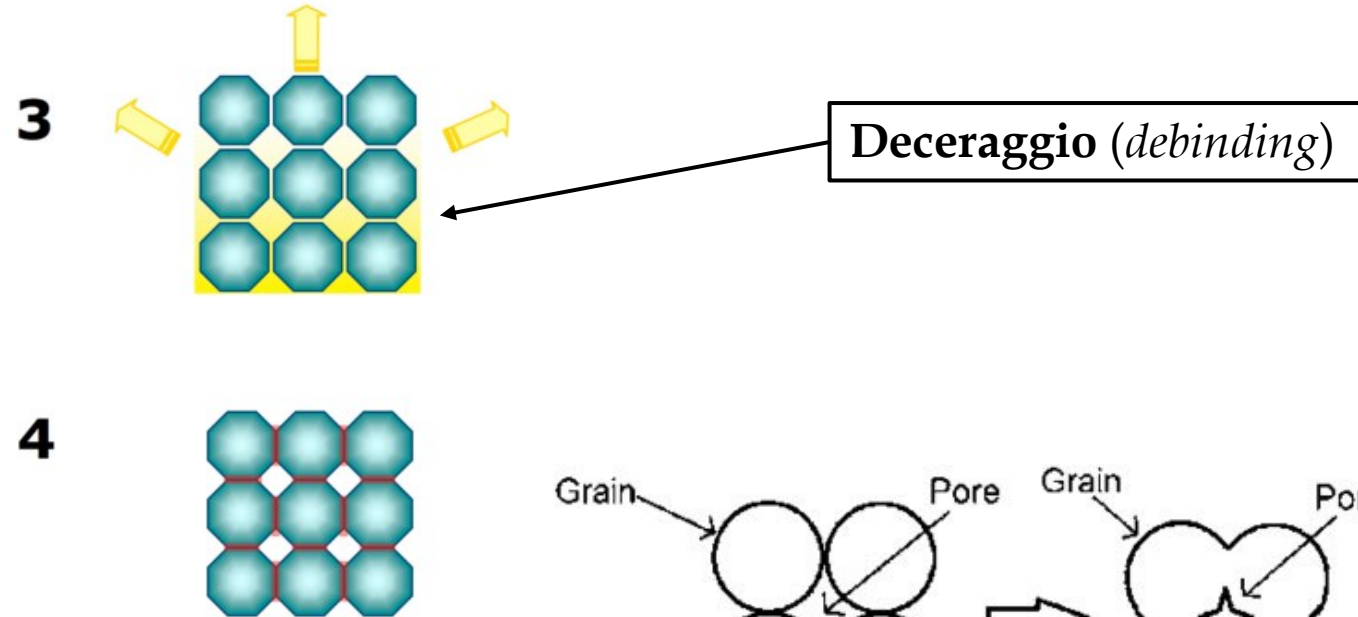
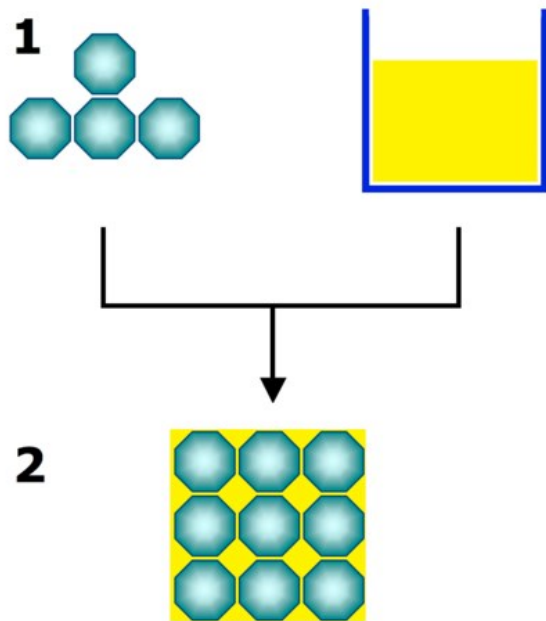
Tecniche additive e stampa 3D FDM



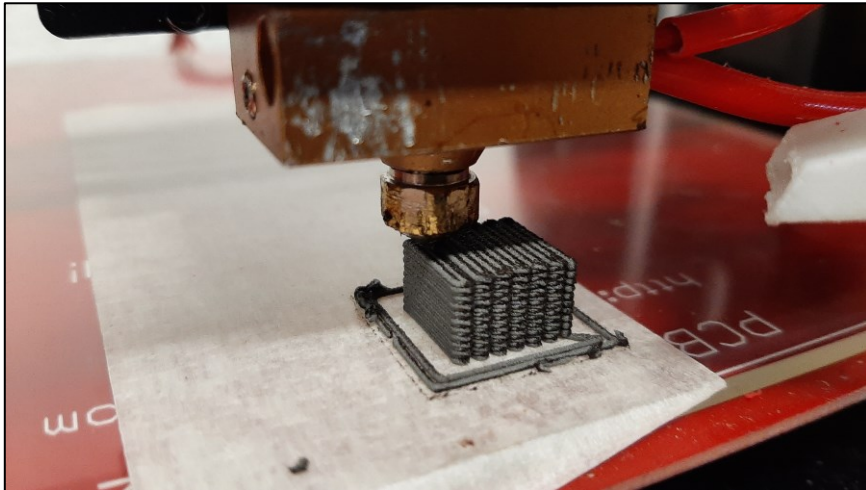
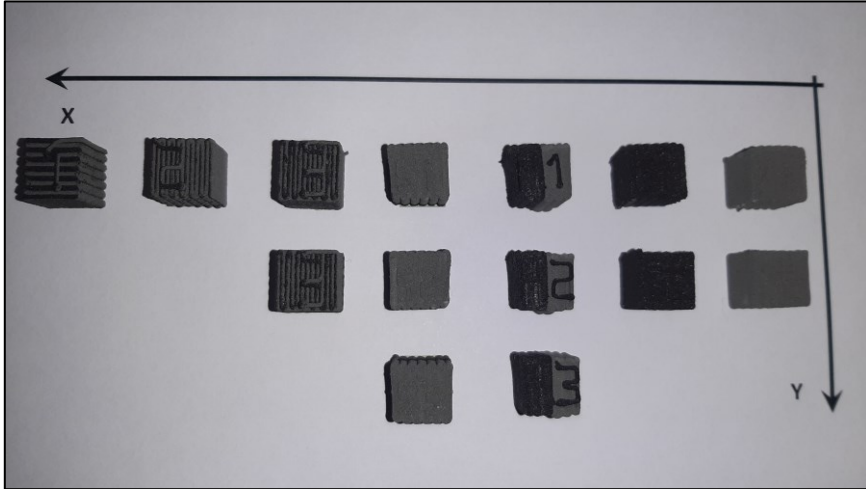
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Sinterizzazione

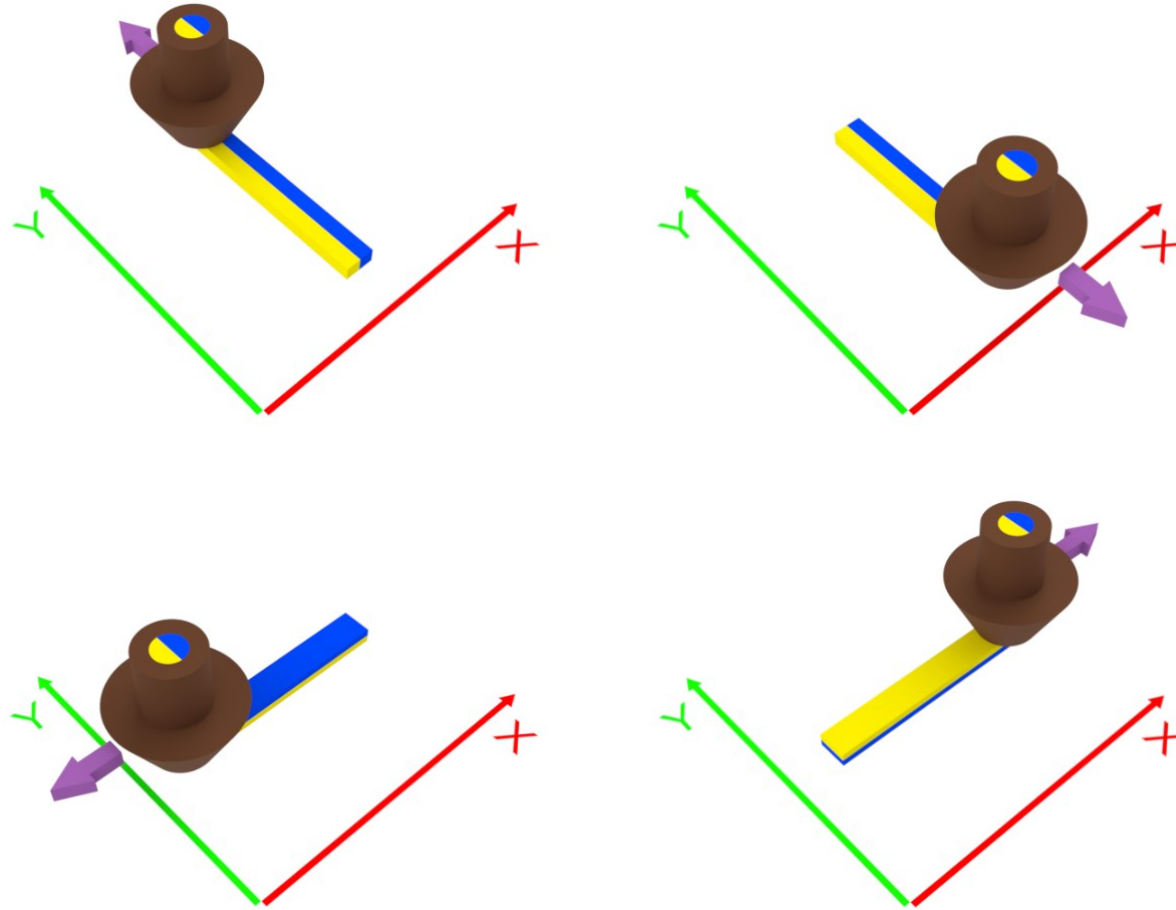


Campioni bimetallici



Campione	Descrizione	Materiale A	Materiale B
1	Coestruso dx/sx	Inconel 718	High Carbon Fe
2	Coestruso avanti/indietro	Inconel 718	High Carbon Fe
3.[1-2]	Coestruso incrociato	Inconel 718	High Carbon Fe
4.[1-2-3]	Mezzo e mezzo dx/sx	Inconel 718	High Carbon Fe
5.[1-2-3]	Mezzo e mezzo sotto/sopra	Inconel 718	High Carbon Fe
6.[1-2]	Solo High Carbon Iron	-	High Carbon Fe
7.[1-2]	Solo Inconel	Inconel 718	-

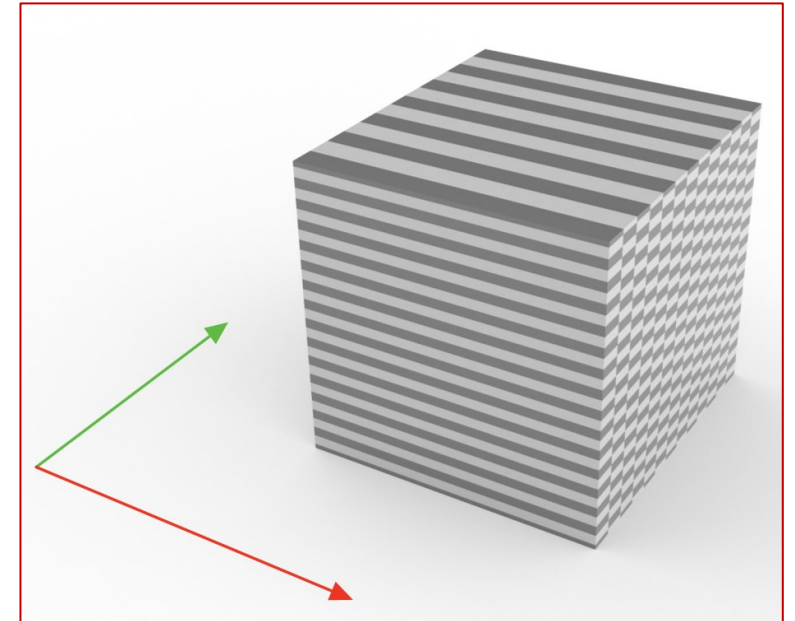
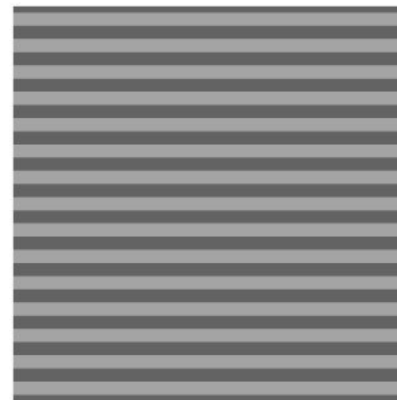
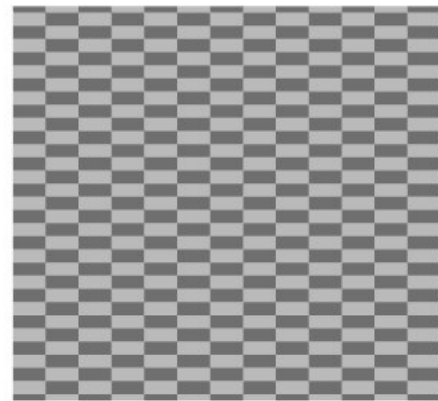
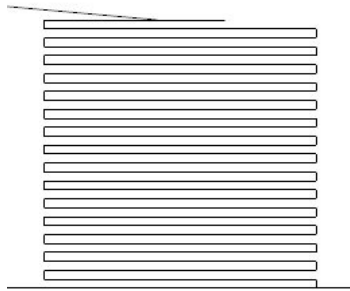
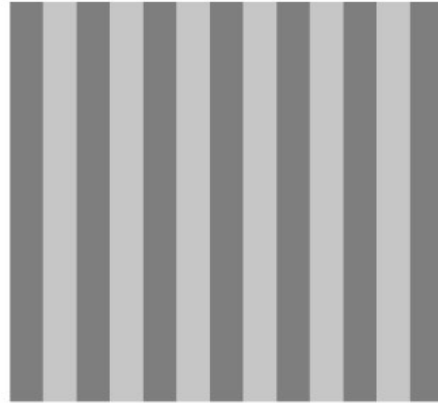
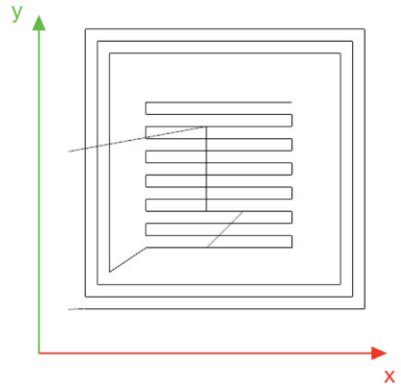
Modalità di stampa e *struttura* dei campioni



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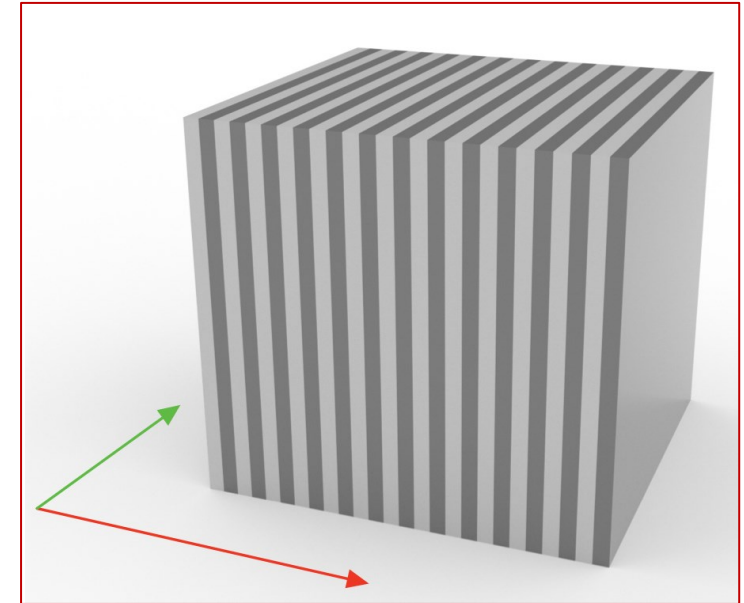
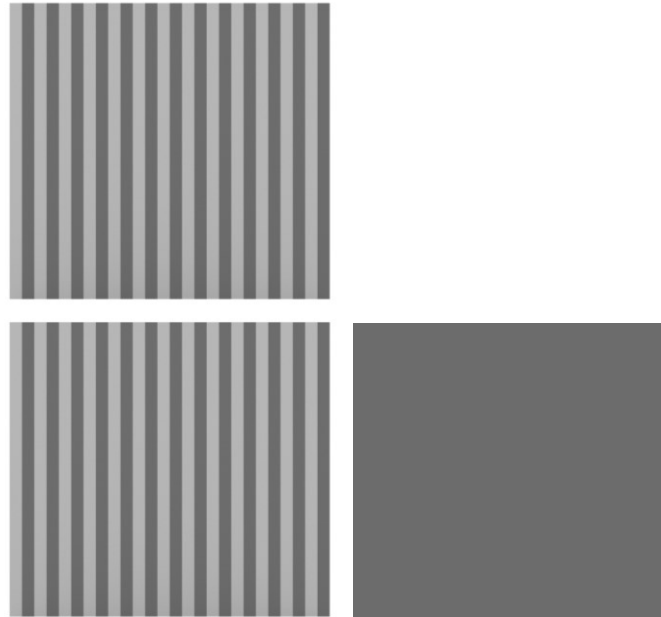
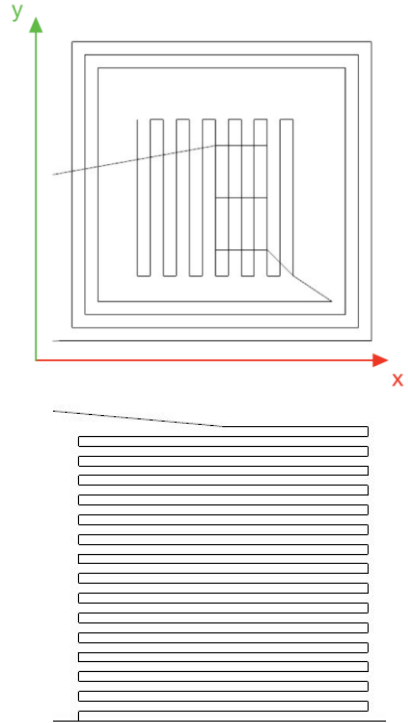
Modalità di stampa – Coestrusione sopra/sotto



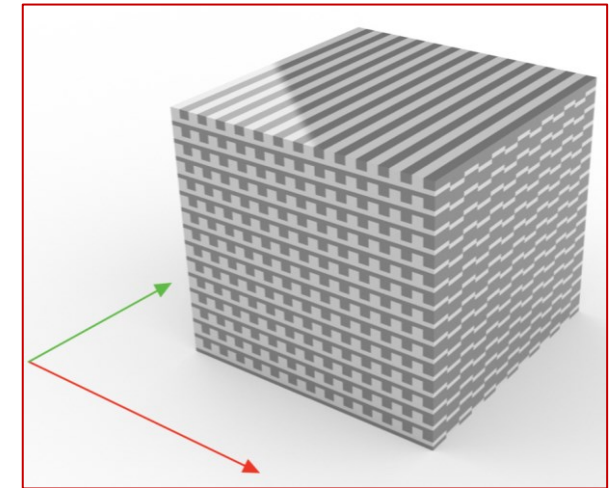
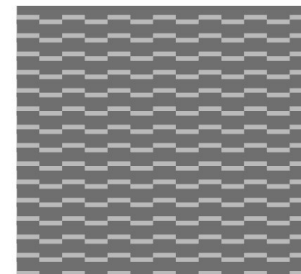
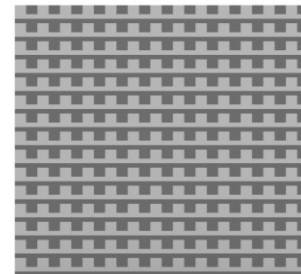
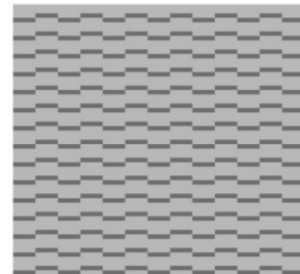
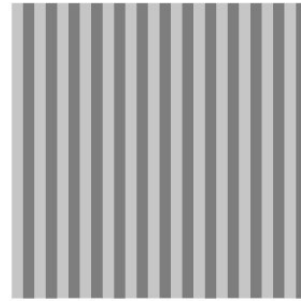
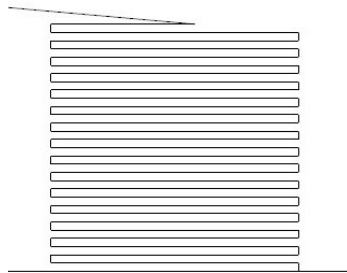
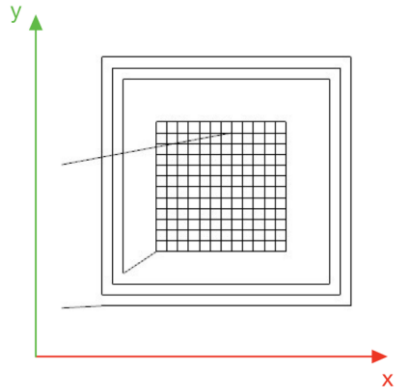
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Modalità di stampa - *Coestrusione destra/sinistra*



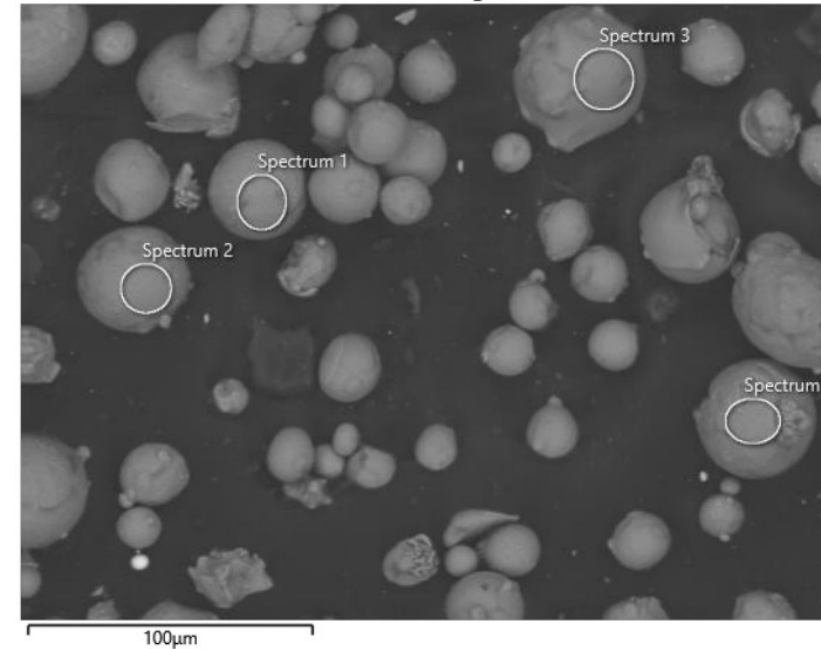
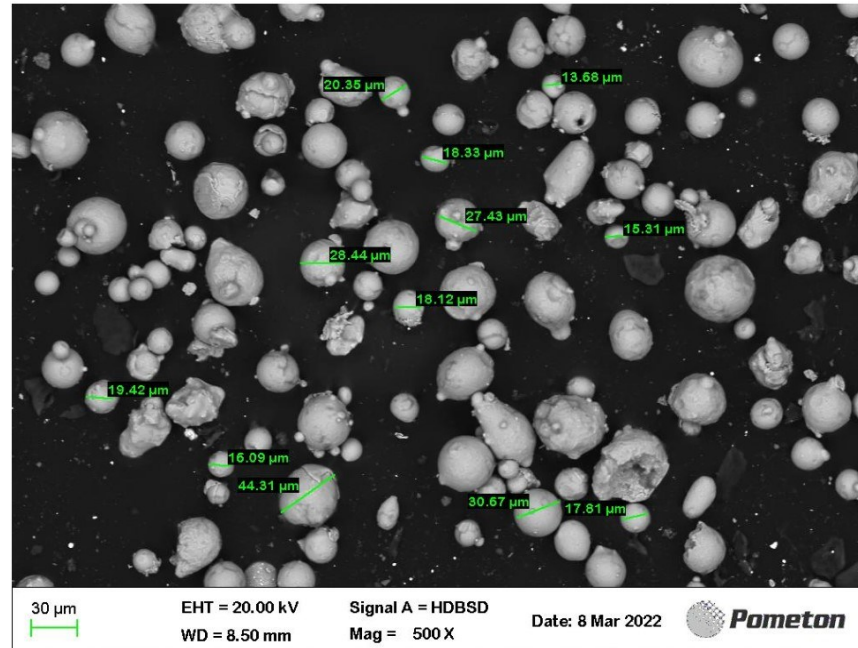
Modalità di stampa – *Coestrusione incrociata*



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Filamenti di partenza – Inconel 718



	Ni	Cr	Fe	Nb	Mo	Ti	Al
	53.2	19.8	18.5	4.2	2.6	1.1	0.7

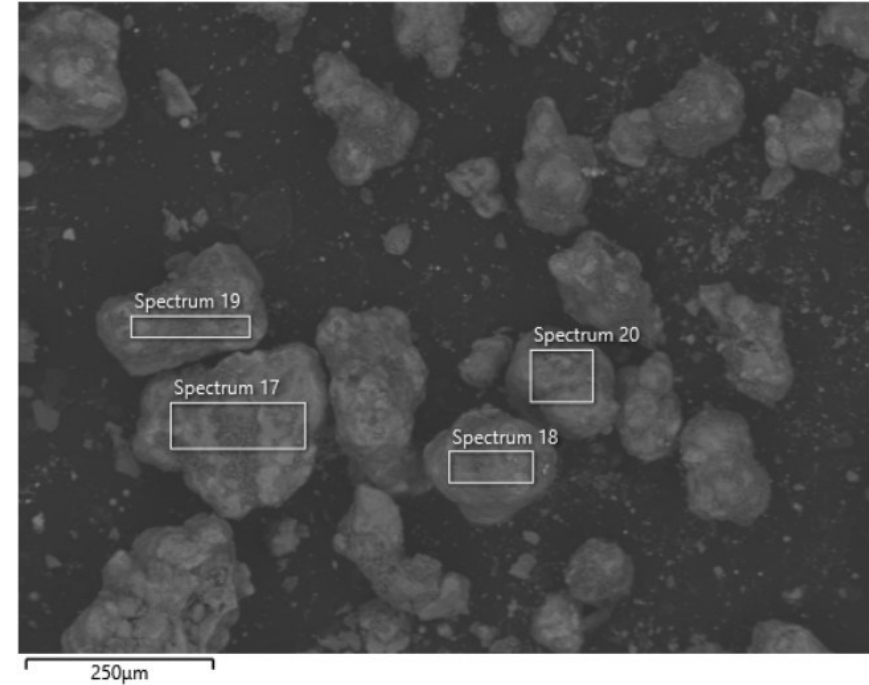
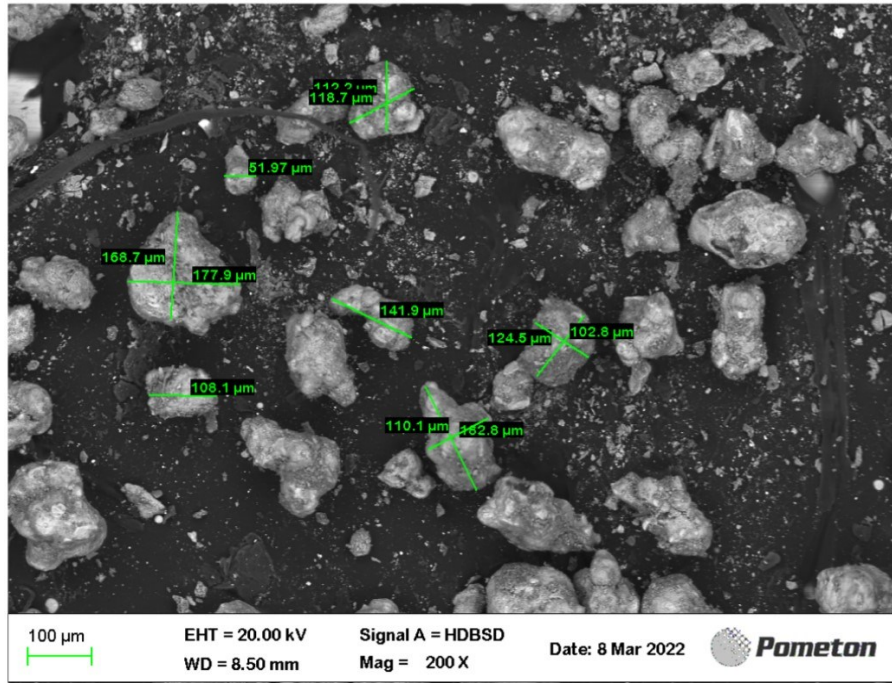
%	Ni+Cr	Cr	Mo	Cu	Co	C	Mn
Min	50	17	2.8	0	0	0	0
Max	55	21	3.3	0.3	1	0.08	0.35
%	Si	P	S	Fe	Ti	Al	Nb+Ti
Min	0	0	0	Bal	0.65	0.2	4.75
Max	0.35	0.015	0.015	Bal	1.15	0.8	5.5



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Filamenti di partenza - High Carbon Iron



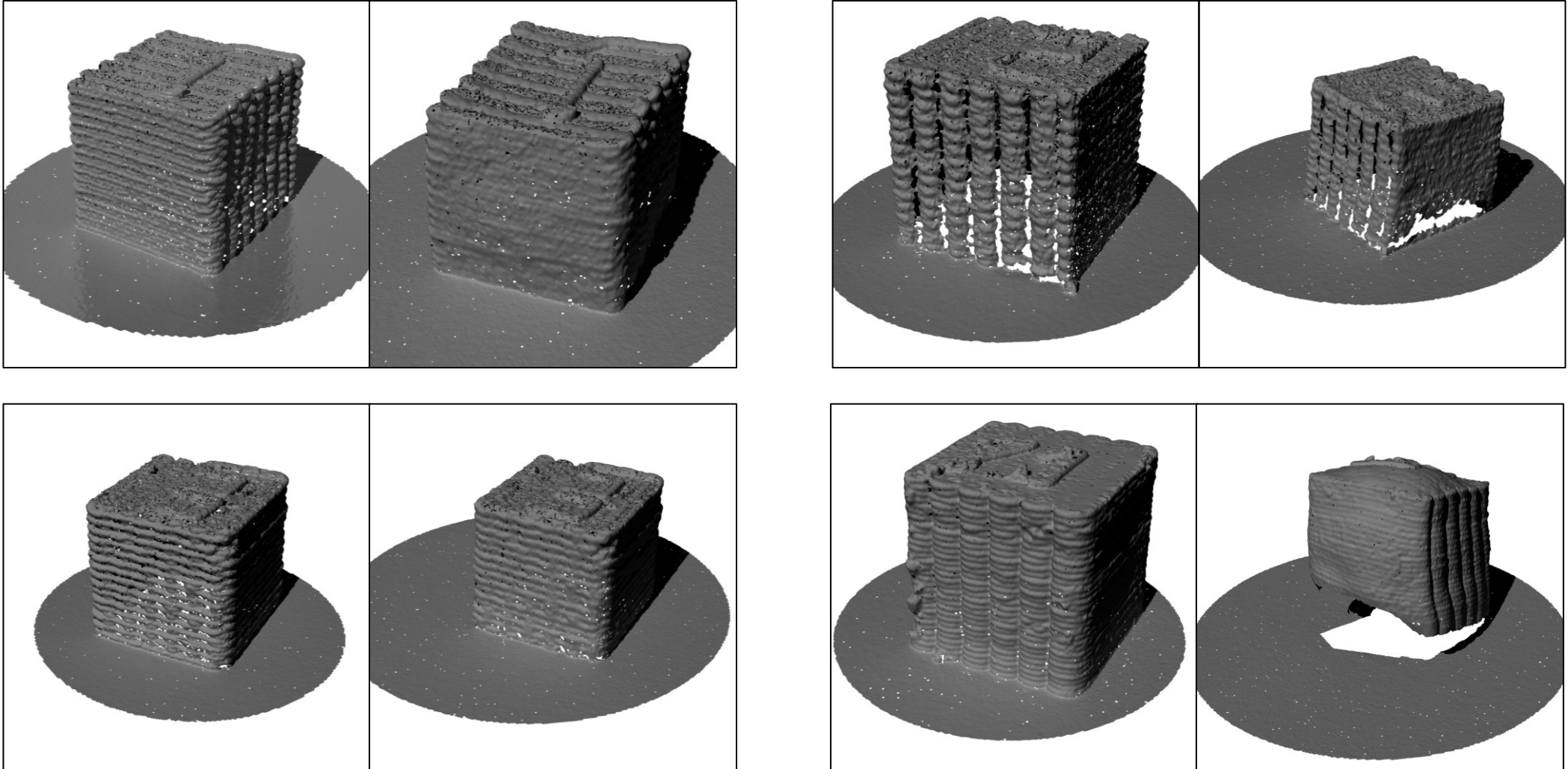
Fe	Si	P	S	Al
93.5	2.3	1.0	1.6	1.7



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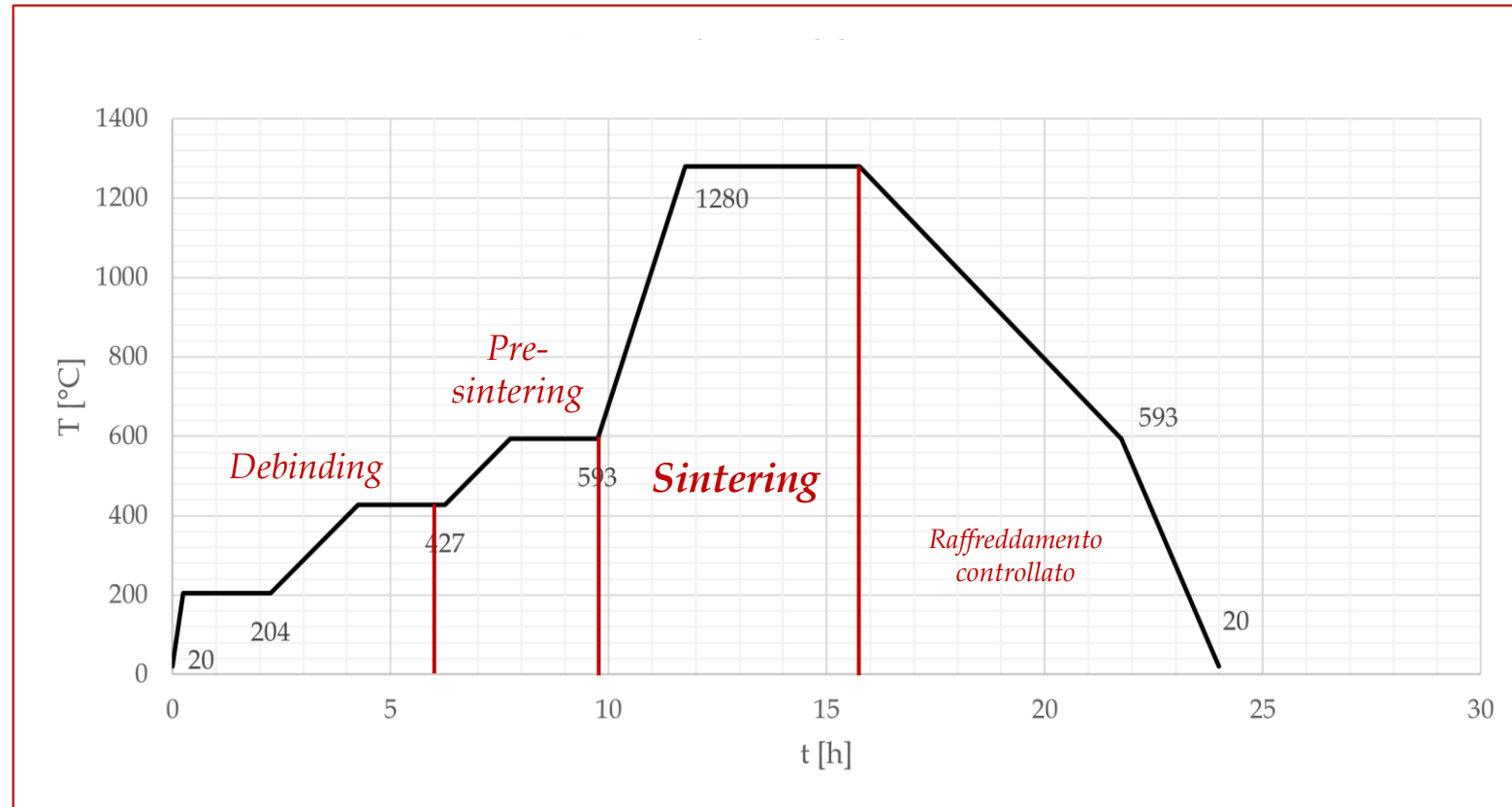
Scansione 3D [pre/post-sinterizzazione]



Massa campioni pre/post-sinterizzazione

Campione	Massa pre-sinterizzazione [g]	Massa post-sinterizzazione [g]
1	6.024	5.018
2	5.589	4.644
3.1	5.885	4.780
3.2	5.767	4.901
7.1	6.535	5.834
7.2	6.578	5.870

Ricetta Trattamento Termico



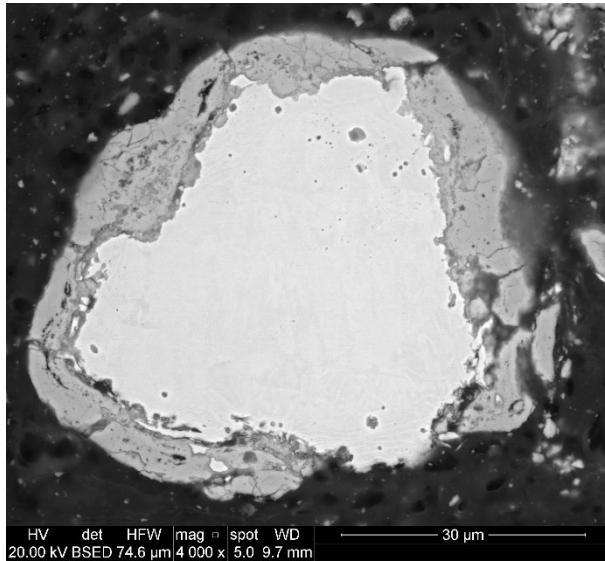
Hold times listed are ideal for a part that is less than a 50mm cube. Hold longer for larger or very thick parts and/or larger crucibles.



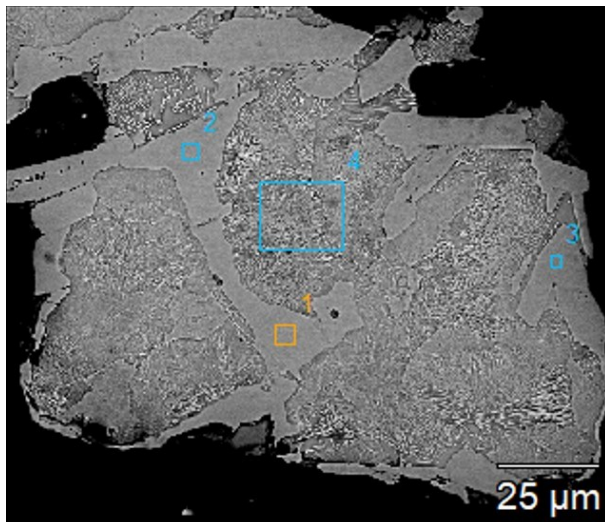
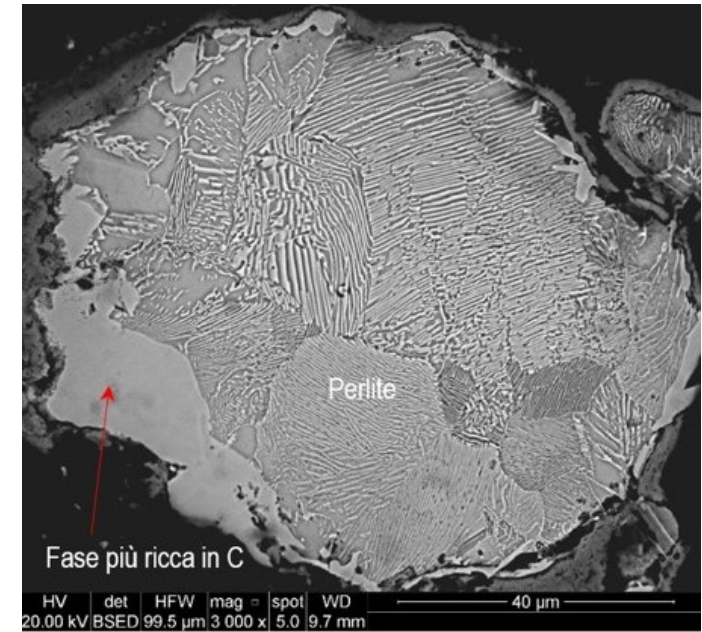
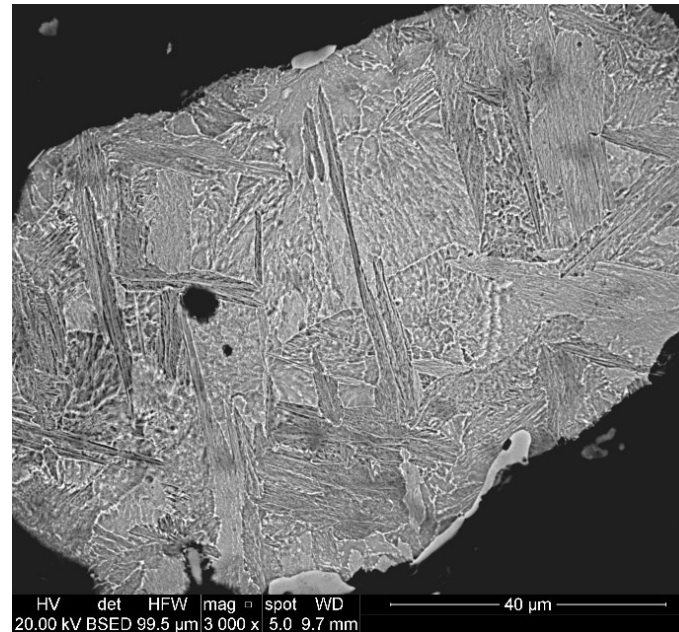
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Struttura e composizione delle polveri - High Carbon Iron

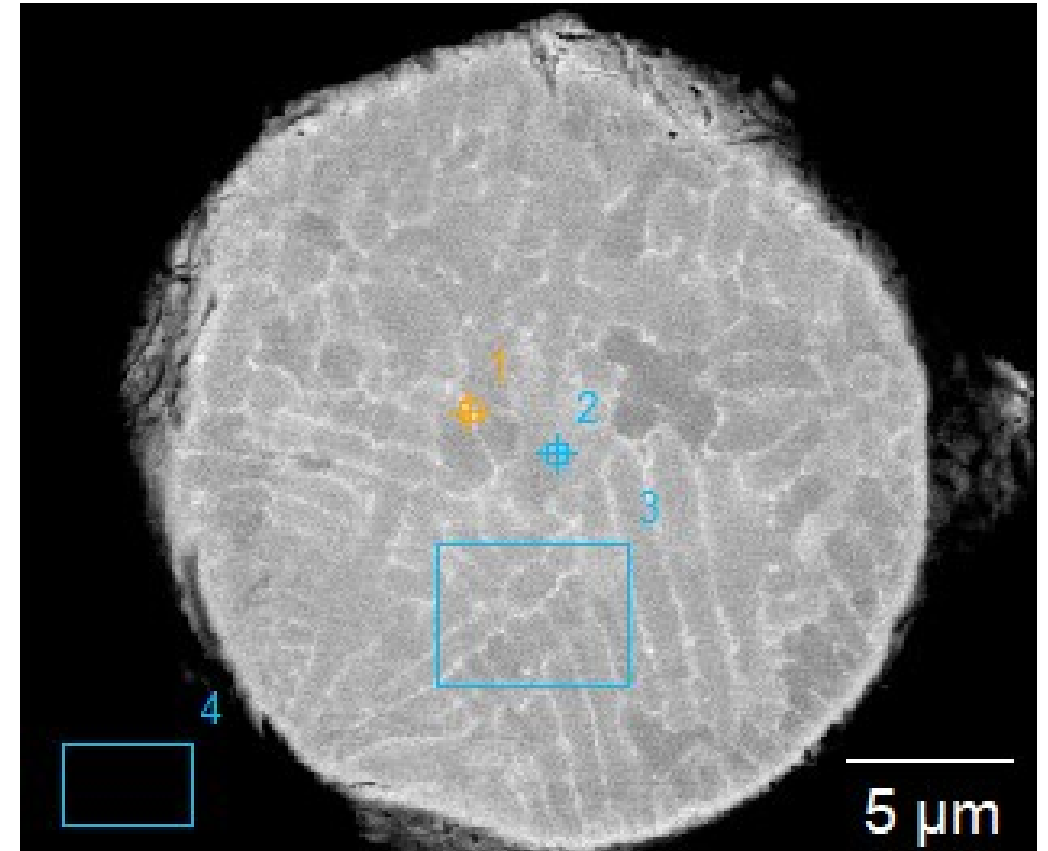
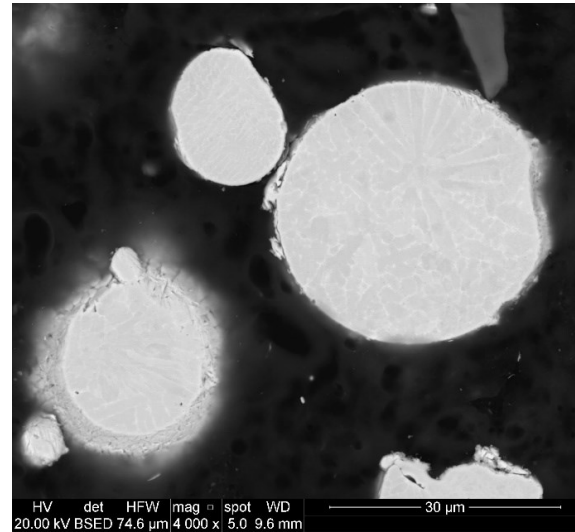
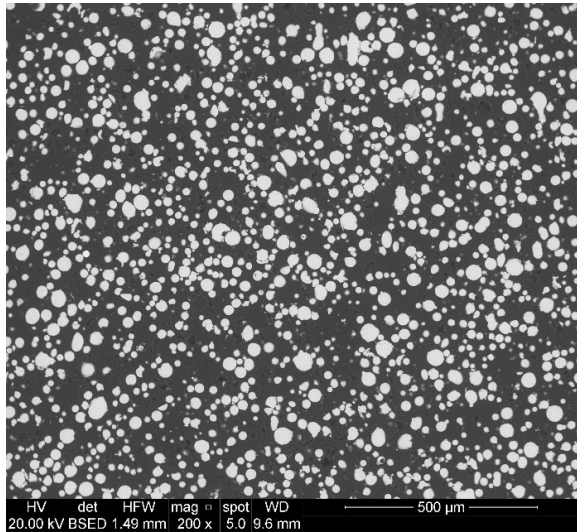


ATTACCO CHIMICO



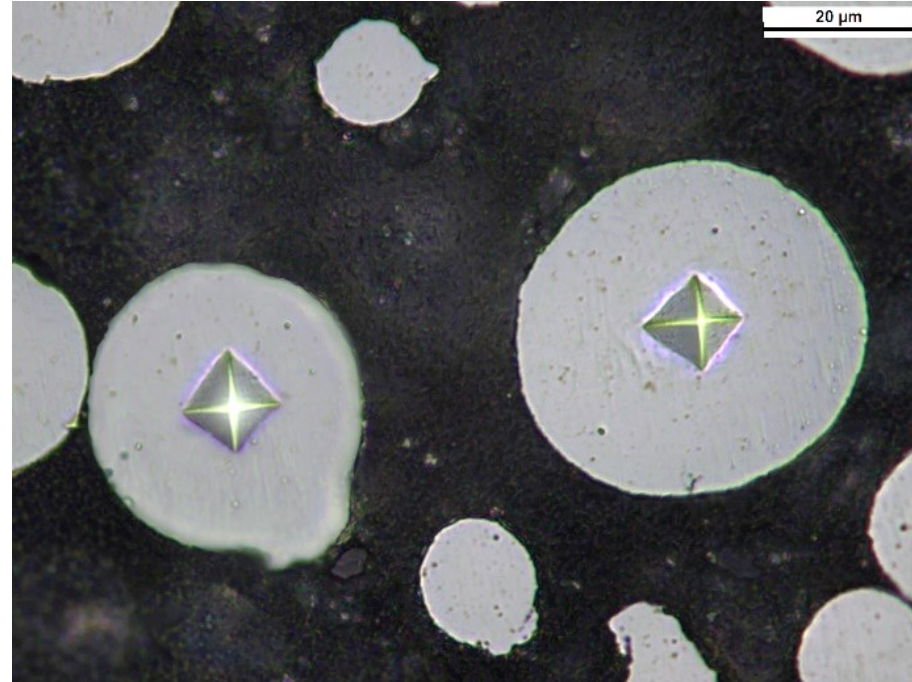
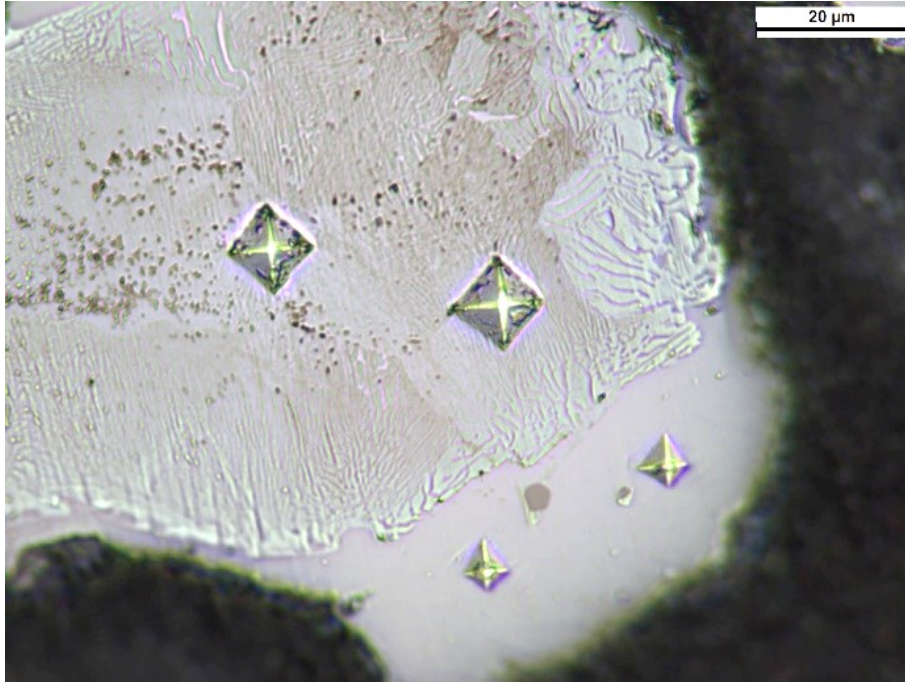
	C	O	Si	P	S	Ti	Fe	Zn
1	8.85	2.32	0.48	0.15	0.06	-	88.14	-
2	8.81	3.98	0.36	0.14	-	-	86.71	-
3	11.23	3.78	0.43	0.15	0.07	-	84.34	-
4	7.75	3.55	0.73	0.17	0.07	-	87.73	-

Struttura e composizione delle polveri - *Inconel 718*



	C	O	Al	Si	Ti	Cr	Fe	Ni	Nb	Mo
1	12.58	5.95	0.31	0.40	0.91	15.05	13.30	40.16	7.83	3.48
2	12.23	5.41	0.35	0.33	0.71	15.98	16.36	41.78	4.02	2.84
3	12.70	5.43	0.34	0.36	0.74	16.16	15.38	41.99	4.43	2.45
4	44.27	21.28	0.11	0.99	0.28	7.10	6.56	17.32	1.17	0.85

Prove di *Microdurezza Vickers*



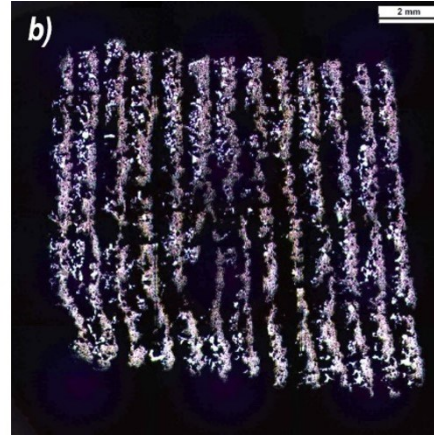
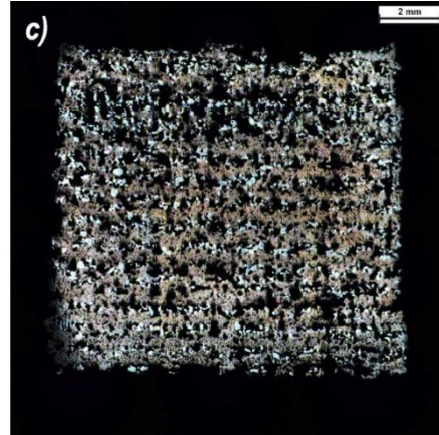
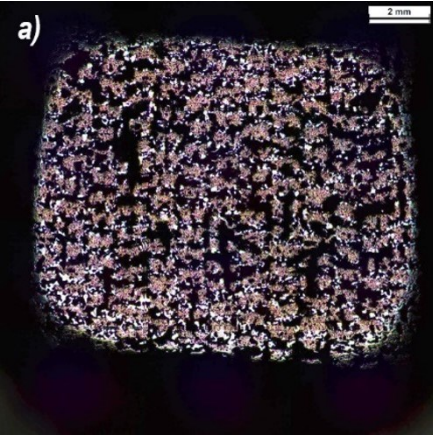
Filamento	Struttura	Microdurezza HV _{0,025}
High Carbon Iron Filamet™	Perlite	320 ± 36
	Fase più ricca in C	1318 ± 102
Inconel 718 Filamet™	Fase austenite	288 ± 17



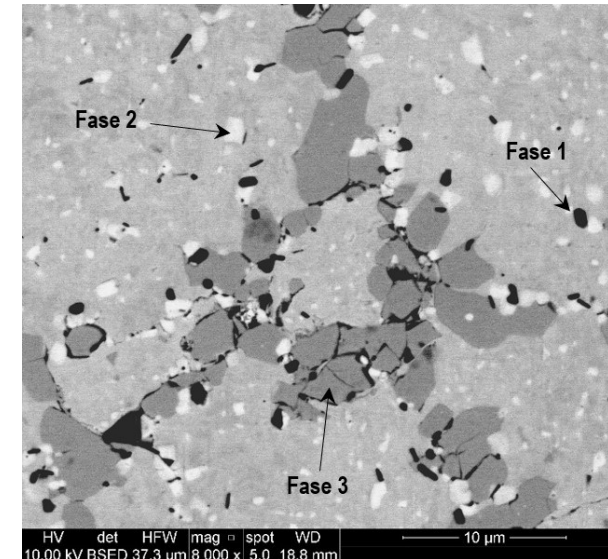
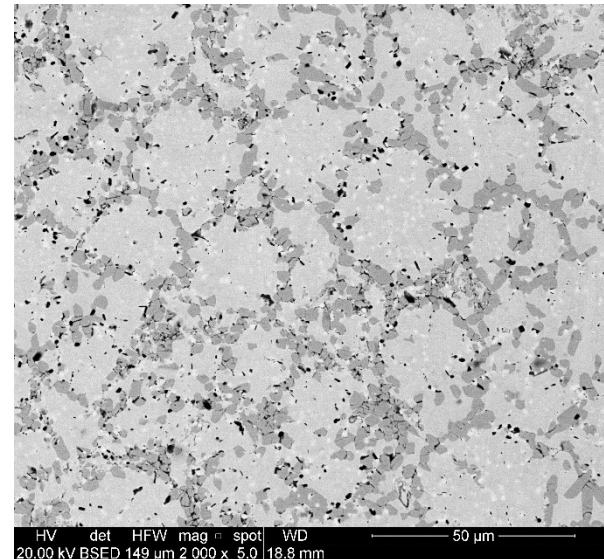
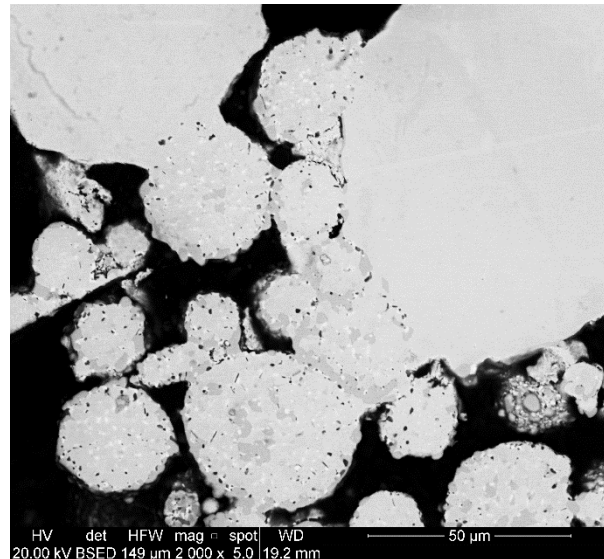
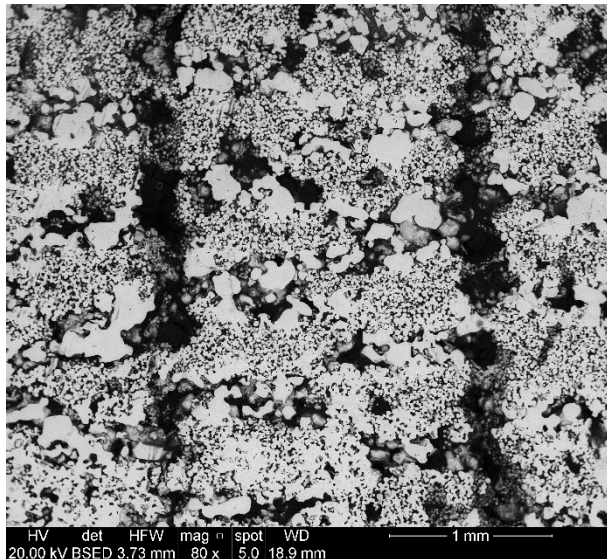
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Macrografie su campioni sinterizzati

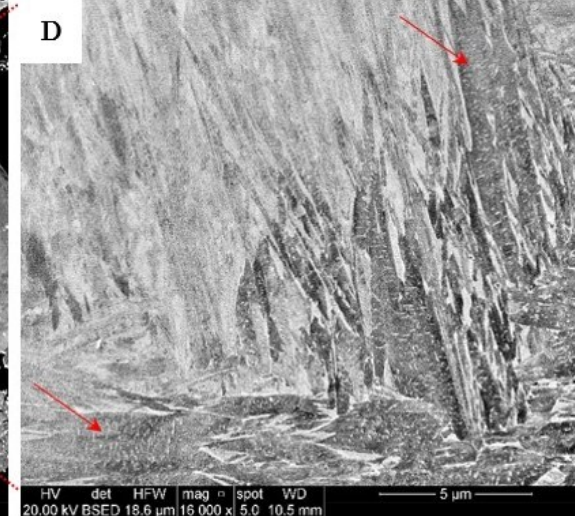
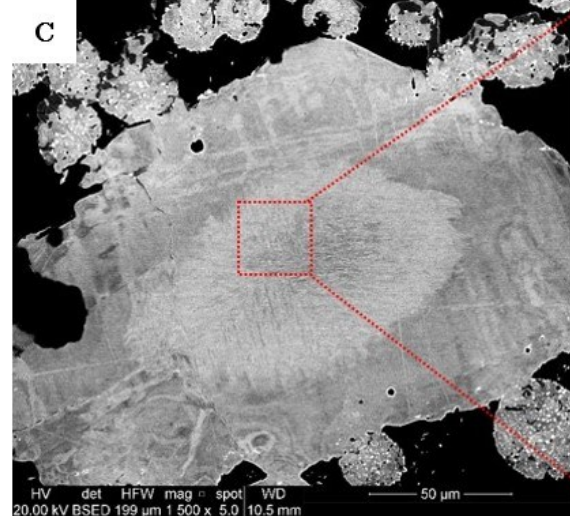
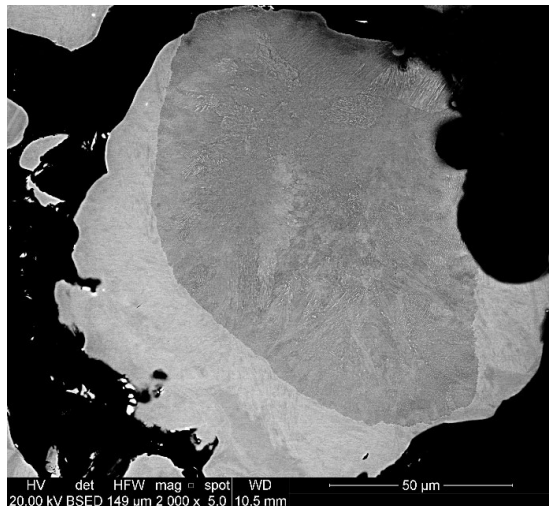
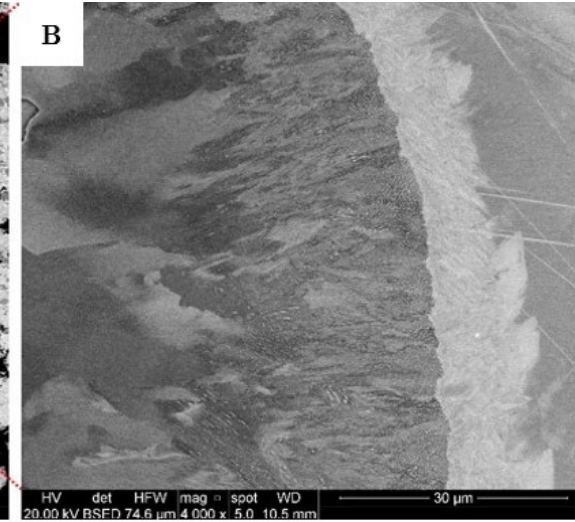
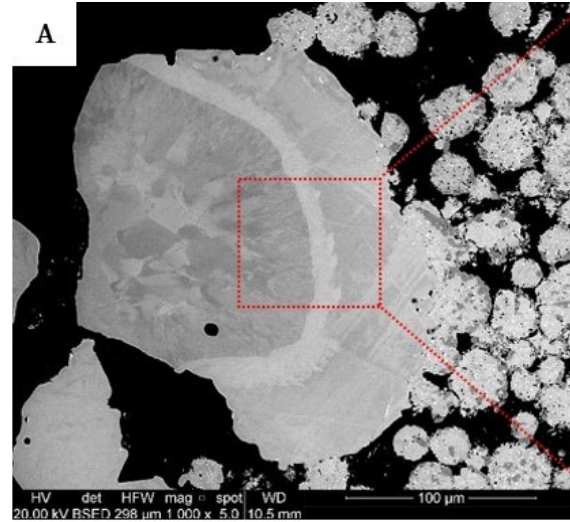
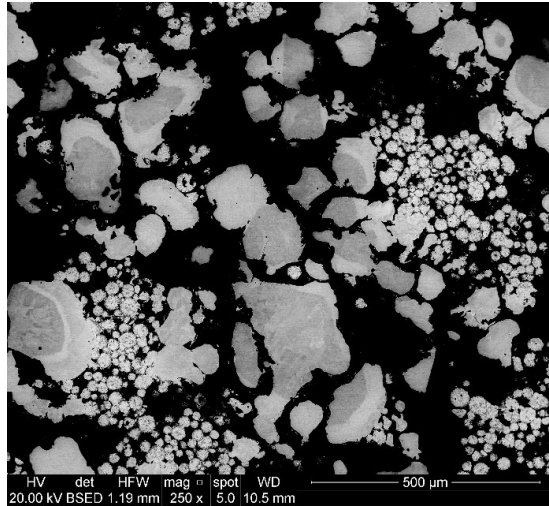


	C	O	Al	Si	Ti	Cr	Fe	Ni	Nb	Mo
<i>Fase 1</i>	3.02	16.25	19.05	0.77	0.74	8.18	24.60	22.49	3.32	1.57
<i>Fase 2</i>	4.52	6.06	0.24	0.73	3.94	8.09	18.77	16.46	35.34	5.85
<i>Fase 3</i>	4.14	3.35	0.27	0.71	0.51	31.20	30.41	23.21	2.30	3.91
<i>Matrice</i>	2.49	3.70	0.26	1.04	0.44	8.10	33.93	46.49	2.03	1.51

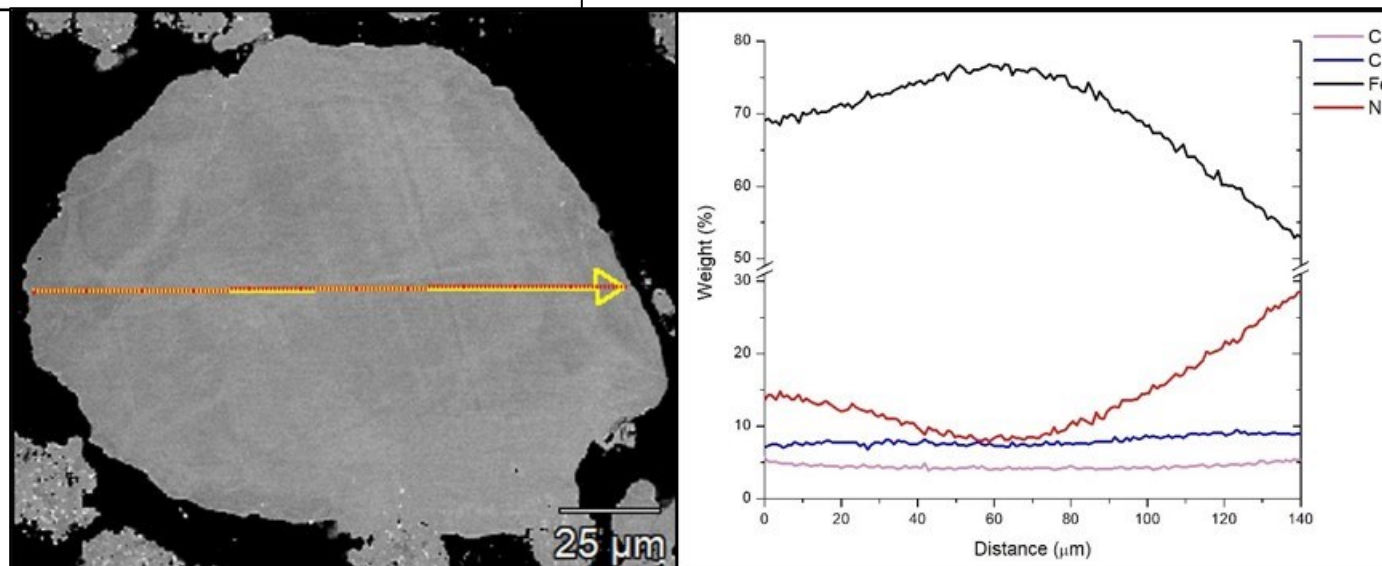
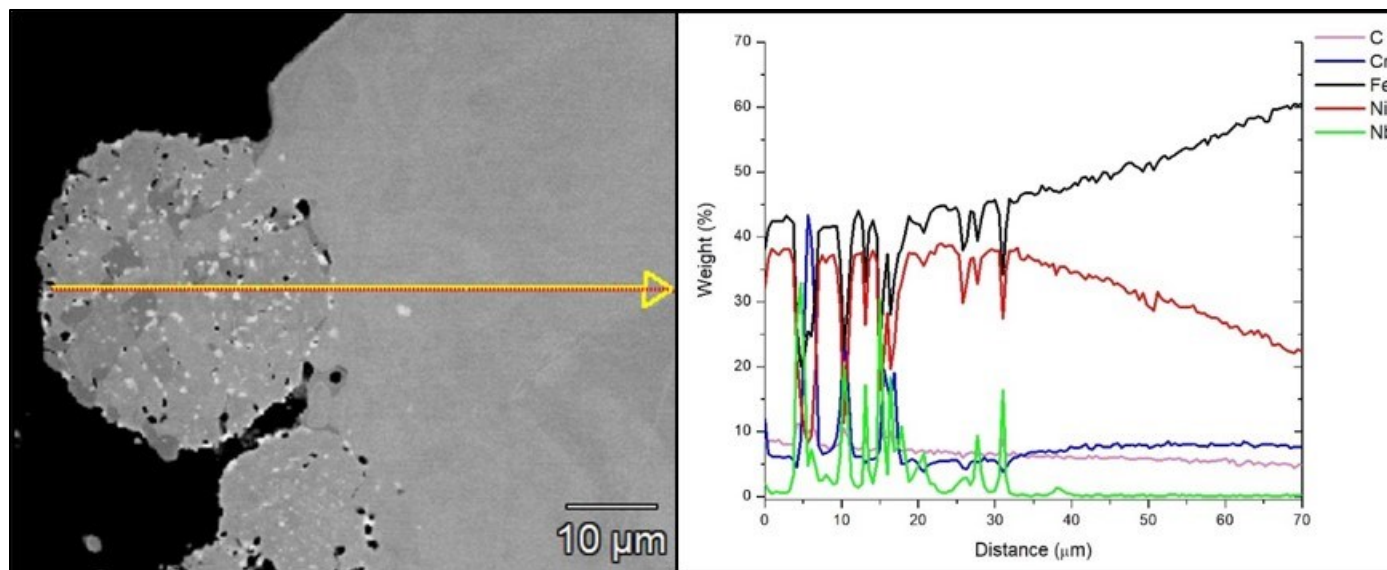


(campione 1 non inglobato)

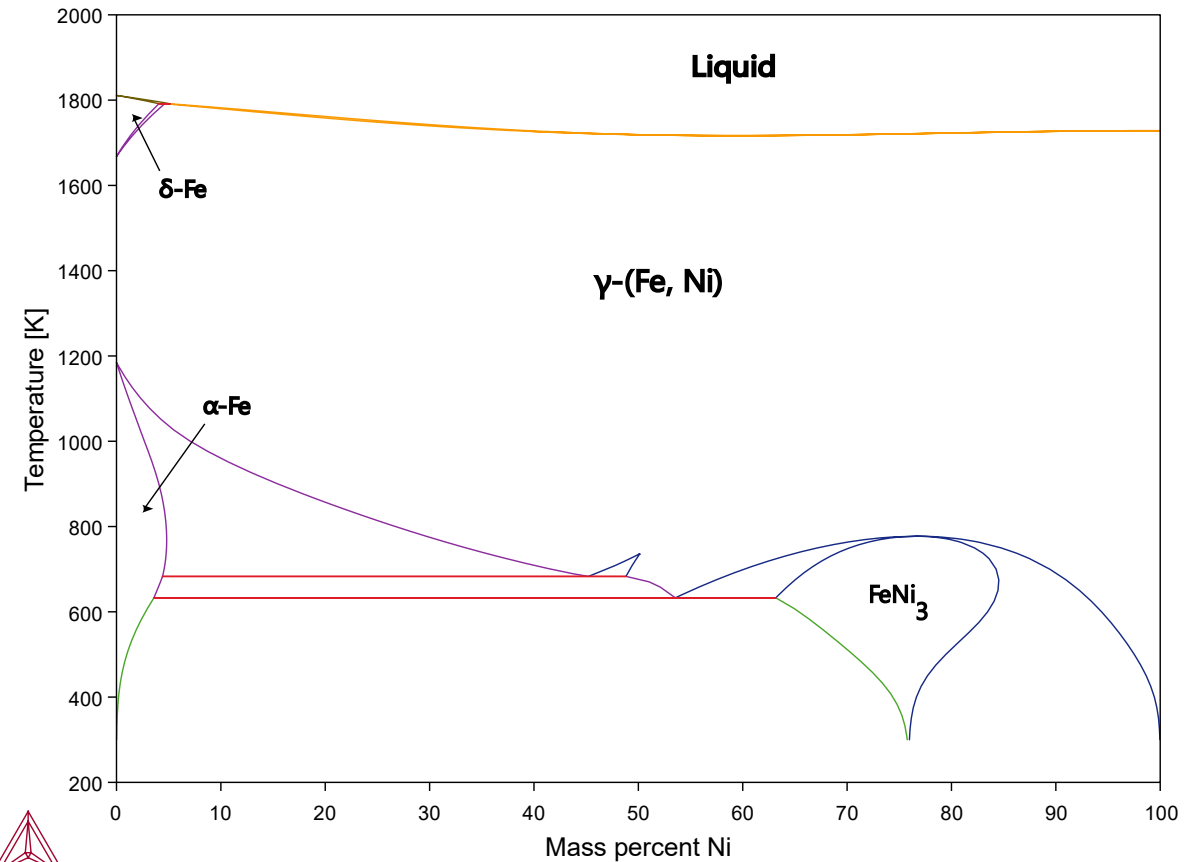
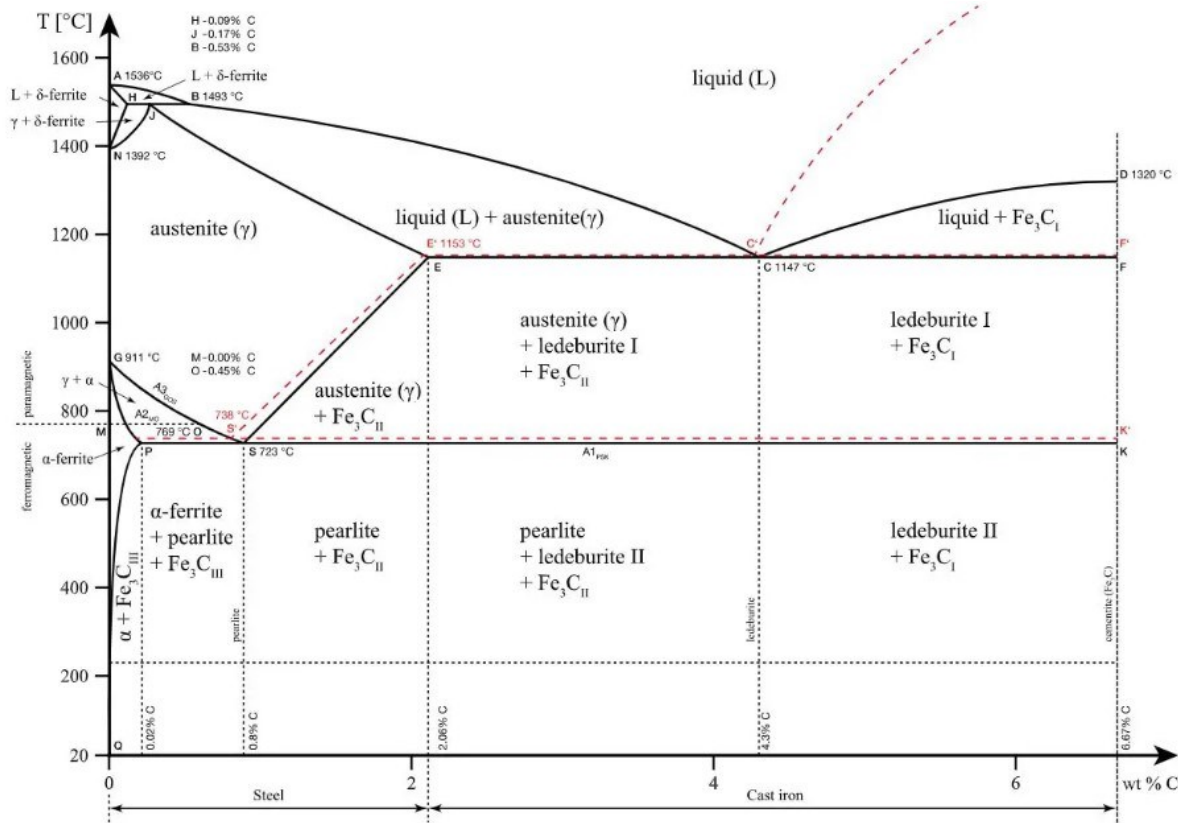
Campione 3.2 *inglobato* e sottoposto ad *attacco chimico*



Profili di concentrazione



Sistema ferro-nichel



Conclusioni



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