

EMERALD

The Education, Scholarships, Apprenticeships and Youth Entrepreneurship

EUROPEAN NETWORK FOR 3D PRINTING OF BIOMIMETIC

MECHATRONIC SYSTEMS

E-toolkit – New materials used

for the developed biomimetic mechatronic systems

Project Title	European network for 3D printing of biomimetic mechatronic systems 21-COP-0019
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Module	Database used for the smart (intelligent) materials properties
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Total Materia used for determination of the materials properties

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Total Materia used for determination of the materials

properties.

1 Total Materia database – Quick search for alloys

Total Materia is the world's most comprehensive materials database, having more than 20,000,000 property records for over 450,000 metallic and non-metallic materials presented in 26 languages. This database is world class quality, service and support, being trusted in over 160 countries, the smallest companies to global industry leaders all receive our complete specialist technical support. Total Materia is proprietary algorithms for the identification of unknown materials, using composition data from analytical sources, find matching materials, property data and equivalents in just seconds. This database is the largest single collection of advanced property data on the planet, having more than 150,000 materials with stress strain, fatigue data and much more for the design community, being a free page. This database permits lightning fast access for finding and comparing equivalent materials, existing international cross-references for 450,000 materials from 74 standards providing over 15,000,000 material connections.

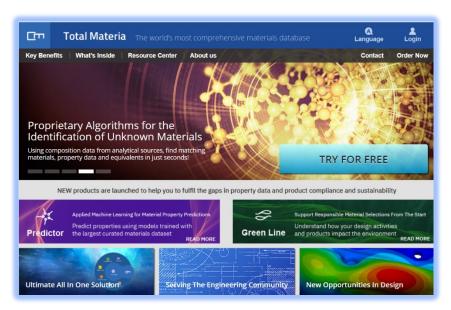


Fig.1. Total Materia database









Total Materia database help solve diverse engineering challenges from the simplest to the complex, being used in: medicine industry, aerospace industry, energy industry, automotive industry, machinery industry, engineering industry, diversified.

By example, for the alloy Ti6Al4 V, we want to know the chemical composition and the mechanical properties, and we click on Advanced Search, as in the Figure 2.

Total Ma The World's Most	ateria Comprehensive METALS Data	base			😵 Select Language	Support Support
PowerDemo Home	Advanced Search	SmartComp	Suppliers	Extended Range	Standard List	Order Now
Material		Standard Numb	er	🔍 Submit	Clear	
Group of Materials All Country/Standard	~	Standard Desc	iption			
- / Approval	~					
Full Text Search Search for						
		4				
—— Chemical Compo	sition (%)					
Element Min.	Max.	Element Mi	n. Max.	E	ement Min.	Max.
C		Mo		(Cu	

Fig.2. Advanced Search

In the figure 3, it is presented the choice of the standard in function of the country and group of materials.

It was choosing the alloy Ti6Al4V, making part of Titanium materials and was choose European Union standard, as in Figure 3. It must specify the material type, as example Bulk Materials, in Figure 4.









Total Ma The World's Most	ateria Comprehensive METALS Data	base			🌸 Select Language	Support 😣 Log out
PowerDemo Home	Advanced Search	SmartComp	Suppliers	Extended Range	Standard List	Order Now
Advanced S						
Material Ti6Al4V		Standard Numb	Der	🔍 Submit	Slear	
	×	Standard Numb		Submit	Clear	
Ti6Al4V Group of Materials	~			Submit	Clear	

Fig.3. European Union standard choice

M Registration information for Total X 🚾 Total Materia :	Subscribers Home × +			~ - o ×
\leftrightarrow \rightarrow C $($ a portal.totalmateria.com/en/search/	l∕quick			G 🕶 🖻 🎓 🗰 🔲 🕕 🗄
M Gmail 💶 YouTube 💡 Maps 🌬 Translate 👼 N	News			
TOTAL SEARCH EX	EXTENDED RANGE DATA PLUS ENVIRO	COMPLIANCE SUPPLIERS SMARTCOMP	EXPORTER TRACKER MATER	ALAL CONSOLE
	Quick Search Adva	nced Search Standard list Material	Discovery	
Bulk	torial Desidenation Bulk Materials Ik Materials X V Material group ulk Materials	✓ Standard ✓ Pr	SEARCH	C
Welcome Irina Bail Sul	dhesives Datings Jubricants Ubstances	490K 80 NUMBER OF STANDARD	20K DATA SOURCES	25M
MESSAGE SAVED SEA		MATERIALS ORGANIZATIONS	S	DATA POINTS
Subscription expires: 04/05/2023 (mm/dd) Want to return to the old version of the Tota <u>Click here to go back</u>	d/yy) tal Materia platform?	Resource Hub UPCOMING WEBINARS RECORDINGS Green Line PRODUCT COMPLIANCE AND SUBTAINABILITY	A A B A B A B A B A B A B A B A B A B A	CTotal Materia Resolving Material Challenges
Cloudy		◎ ◎ 🖻 🕸 🚔 0 🖤	a 🔮 🧟	∧ ROU

Fig.4. Material type

In figure 5, it is specifying the material group and in this case, nonferrous alloys and European standard choice, as in figure 6.









Material group 🗸 🗸	European Union/EU × 🗸
Q Search	EU
	🗌 Finland
 Ferrous Alloys Nonferrous Alloys 	SFS
 Polymers 	France
Ceramics	AFCEN
Composites	AFNOR NF
Fibers	
Cements	
Honeycombs	BV
Foams	Germany
▶ 🗌 Wood	DIN

Fig.5. Material group

Fig.6. European standard choice

	Total Materia The work	d's most comprehensive materials database	Metric Imperial Units	😧 Irina Baila English 🔻 🕣 Log out
	TOTAL SEARCH EX	TENDED RANGE DATA PLUS ENVIRO COMPLIAN	CE SUPPLIERS SMARTCOMP EXPORTER	TRACKER MATERIAL CONSOLE
÷	÷	Quick Search Advanced Search	ch Standard list Material Discovery	
P	Quick Search			
		art of your search criteria as part of the material design	ation.	
EVOU		or your search, please click here		
1	would like to view more possible matches t	or your search, please <u>click here.</u>		
1	(s) found: 21	for your search, please <u>click here.</u>		ADD TO MATERIAL LEST BUILDER
1		or your search, please <u>click here.</u> STANDARD	COUNTRY / PRODUCER	■ AUD TO MATCHIAL LIST BUILDER ← FORWARD TO CLASSIFICATION
esult	(s) found: 21		COUNTRY / PRODUCER France	
esult	(s) found: 21 MATERIAL	STANDARD		CLASSIFICATION
esult	(s) found: 21 MATERIAL MIM-TIGAl4V-600	STANDARD AFNOR NF	France	CLASSIFICATION Ferrous Alloys / Sintered powdered metals
esult	(s) found: 21 MATERIAL MIM-TI6Al4V-600 MIM-TI6Al4V-600	STANDARD AFNOR NF ASRO	France Romania	CLASSIFICATION Ferrous Alloys / Sintered powdered metals Ferrous Alloys / Sintered powdered metals
esult	(s) found: 21 MATERIAL MIM-TI6Al4V-600 MIM-TI6Al4V-600 MIM-TI6Al4V-600	STANDARD AFNOR NF ASRO B.S.	France Romania United Kingdom	CLASSIFICATION Ferrous Alloys / Sintered powdered metals Ferrous Alloys / Sintered powdered metals Ferrous Alloys / Sintered powdered metals
esult	(s) found: 21 MATERIAL MIM-TI6AI4V-600 MIM-TI6AI4V-600 MIM-TI6AI4V-600 MIM-TI6AI4V-600	STANDARD AFNOR NF ASRO B.S. BDS	France Romania United Kingdom Bulgaria	CLASSIFICATION Ferrous Alloys / Sintered powdered metals
tesult	(s) found: 21 MATERIAL MIM-TIGAI4V-600 MIM-TIGAI4V-600 MIM-TIGAI4V-600 MIM-TIGAI4V-600 MIM-TIGAI4V-600	STANDARD AFNOR NF ASRO B.S. EDS CSN	France Romania United Kingdom Bulgaria Czech Republic	CLASSIFICATION Ferrous Alloys / Sintered powdered metals Ferrous Alloys / Sintered powdered metals

Fig.7. Different Ti6Al4V producers

When we give a quick search, as in figure 7, are presented different Ti6Al4V producers from different countries and using different standards.













Fig.8. Ti6Al4V standard Fr AFNOR NF-Mechanical properties

The results it is the mechanical properties of the alloy Ti6Al4V, conforming of FR AFNOR NF standard, as in figure 8 and figure 9.

FEMPERATURE	PROPERTY /	VALUE	
□ > 300°C	YIELD STRENGTH, RP0.2	≥ 600 MPa	III view details
🔲 100 - 300°C	TENSILE STRENGTH	≥ 800 MPa	III view details
□ 30 - 100°C	ELONGATION, A	≥3%	III view details
🗹 0 - 30°C			
□ < 0°C	ROCKWELL HARDNESS (HR)	30	III view details
	VICKERS HARDNESS (HV)	300	III view details

Fig.9. Mechanical properties Ti6Al4V at the temperature between 0-30°C

ELECTED REFEREN	NCE				
EN ISO 22068: 2	014 / Sintered-metal injec	tion-moulded materials - Spe	cifications		
RITERIA	VALUE	UNIT	NOTE	CAS NUMBER	CRITICAL RAW MATERIALS CONFLICT MINERALS
AI.	5.0 - 7.0	96		7429-90-5	
C.	≤ 0.2	96		2440-44-0	
М	S 0.1	95		7727-37-9; 17778-88-0	
D	± 0.4	96		7782-44-7: 17778-80-2	
Other total	\$ 1 .0	95			
1			Balance	7440-32-6	Listed
V	3.0 - 5.0	%		7440-62-2	Listed

Fig.10. Chemical composition of Ti6Al4V









In figure 9, the database gives us all information about the mechanical properties of the alloy Ti6Al4V in function of the temperature used in the process where it is used this material. In figure 10, the database shows us the chemical composition of the alloy Ti6Al4V.

2. Total Materia database – Advanced Research for alloys

In the case of Advanced Research, by example for the Ti6Al4V, producer Vday Additive Manufacturing Technology Co., it is given the classification of different Ti alloys producers, as in figure 11.

	SEARCH CLEAR			
Resu	t(s) found: 154			and to mate
₽+	MATERIAL	STANDARD	COUNTRY / PRODUCER	CLASSIFICATION
1	TI6Al4V	PROPRIETARY	Vday Additive Manufacturing Technology Co., Ltd.; 3T Additive Ma	Nonferrous Alloys / Titanius 3D Materials
2	TI-6Al-4V	AFNOR NF	France	Nonferrous Alloys / Titaniu
3	Ti-6Al-4V	AS	Australia	Nonferrous Alloys / Titaniu
4	Ti-6Al-4V	ASRO	Romania	Nonferrous Alloys / Titaniu
5	Ti-6Al-4V	B.S.	United Kingdom	Nonferrous Alloys / Titaniu
6	TI-6Al-4V	BDS	Bulgaria	Nonferrous Alloys / Titaniu
7	Ti-6Al-4V	CSN	Czech Republic	Nonferrous Alloys / Titaniu
8	Ti-6Al-4V	DIN	Germany	Nonferrous Alloys / Titaniu
9	Ti-6Al-4V	EN	European Union	Nonferrous Alloys / Titaniu
10	Ti-6Al-4V	GB	China	Nonferrous Alloys / Titaniu

Fig.11. Ti6Al4V alloy used in Additive Manufacturing

	Co., Ltd.; 3T Additive Manufacturing Ltd (former 3T BPD Ltd.); Herr ghai Research Institute of Materials: Optimal Material Technology C		DRKS GmbH; Sondas,	n ap. z c.o.; Sintevis; Arcam AB; Materialise; Digital Metal (part of Hög	anās :	50 Comeosition 73 Mechanical Propertie 22 Physical Properties
3D Materials	IN PHYSICAL PROPERTIES	CROSS REFERENCING		► TRACKER	1	3 Heat Treatment 1 Matallography * Machinability
Yind Strength, Rol 2, 744 – 1530.1 MPa Tensils farmigh: 843 – 1282,4 MPa Exception, A, 3,5 – 18 %	Hodulus of Electrolity 199 – 124 GPs Density ≥ 2.5 kg/dwr Doefficient of Thermal 7.6 – 7.9 30 */*C Expension (CTE)	185 0 Al Official	103 Other	Last spidate 2022-12 Hechmical Properties, Physical Properties, Composition, Heat Treatment		EXTENDED RANGE 10 Stress Strais Diagram * Eormakility 1 Falipur Data * Erecture Mechanica * Greep Data
THETIC VIEW DETAILS VIEW		PROPE	TTY / VALUE			DATA PLUS * Zolets Costings Dimensions 3 Tribology
□ > \$00*C		VIELD STRENGTH, RP0.2	744 - 1110.1 M	Pa 🗮 view details		Envino * Corresion
[] 100-300*C		TENSILE STRENGTH	843 - 1282 .4 M	Pa 🗏 view details		 Ascins Weatherability Insadiation
30 - 100°C		ELONGATION, A	3.5 - 18 %	III view details		SUPPLIERS (BETA)
□ <0°C		REDUCTION OF AREA	40 %	🗐 view details		Alternative Supplier
•		BRINELL HARDNESS (HE)	294	≣ view.details		
		ROCKWELL HARDNESS (HR)	25-320	III <u>view details</u>		
		VICKERS HARDNESS (IV)	200 - 405	🗮 view details		

Fig.12. Mechanical properties of Ti6Al4V used in Additive Manufacturing









In the figure 12, are presented the mechanical properties of Ti6Al4V used in Additive Manufacturing, for different temperature domains. The chemical composition of Ti6Al4V used in Additive Manufacturing is given in the figure 13. In the figure 14, the physical properties of Ti6Al4V used in Additive Manufacturing, for different temperature domains.

Ti6Al4V (PROPRIETARY) ☆

REFERENCES					
③ 3T Additive Manufac	cturing Ltd, Product Data Sheets / Available	at: www.3t-am.com, visited 2019			
Arcam AB, Product E	Data Sheets / Available at: www.arcam.com,	, visited 2015			
O Digital Metal, Produc	ct Data Sheets / Available at: www.digitalme	etal.tech, visited 2021			
Heraeus Additive Ma	anufacturing GmbH, Product Data Sheets / A	Available at: www.heraeus.com, visited	d 2020		
O Meltio, Product Data	Sheets / Available at: https://meltio3d.com	n/, visited 2022			
O Shanghai Research I	Institute of Material, Product Data Sheet / A	vailable at: www.srim.com.cn, visited	2022		
SELECTED REFEREN	CE acturing Ltd, Product Data Sheets / Av	vailable at: www.3t-am.com, visit	ed 2019		
CRITERIA	VALUE	UNIT	NOTE	CAS NUMBER	CRITICAL RAW MATERIALS CONFLICT MINERALS
CRITERIA Al	VALUE 5.50 - 6.75	UNIT %	NOTE	CAS NUMBER 7429-90-5	CRITICAL RAW MATERIALS CONFLICT MINERALS
Sector Sector			NOTE		CRITICAL RAW MATERIALS CONFLICT MINERALS
AL	5.50 - 6.75	%	NOTE	7429-90-5	CRITICAL DAW MATERIALS CONFLICT MINERALS - -
<u>Al</u>	5.50 - 6.75 ≤ 0.08	%	NOTE	<u>7429-90-5</u> 7440-44-0	CRITICAL RAW MATERIALS CONFLICT MINERALS - - - -
Al C Fe	5.50 - 6.75 ≤ 0.08 ≤ 0.3	96 96 96	NOTE	7429-90-5 7440-44-0 7439-89-6	-
Al C Fe H	5.60 - 6.75 ≤ 0.08 ≤ 0.3 ≤ 0.015	54 54 54 54 55	NOTE	7429-90-5 7440-44-0 7439-89-6 1333-74-0	
Al C Fe H N	5.50-6.75 ≤0.08 ≤0.3 ≤0.015 ≤0.05	55 55 55 55 55 55 55	NOTE	7 <u>429-90-5</u> 7 <u>440-44-0</u> 7 <u>439-89-6</u> 1 <u>333-74-0</u> 7 <u>727-37-9</u> :17778-88-0	

Fig.13. Chemical composition of Ti6Al4V used in Additive Manufacturing

TEMPERATURE	PROPER	RTY / VALUE
□ > 300°C	MODULUS OF ELASTICITY	100 — 124 GPa
☐ 100 - 300°C	DENSITY	≥ 2.5 kg/dm³
□ 30 - 100°C	COEFFICIENT OF THERMAL EXPANSION (CTE)	7.6 − 7.9 10 ⁻⁶ /°C
□ < 0°C	MELTING TEMPERATURE	1600 – 1750 °C

Fig.14. Physical properties of Ti6Al4V used in Additive Manufacturing









Reference	Descriptions
rcam AB, Product Data Sheets / Available at: www.arcam.com, visited 2015	Hot Isostatic Pressing (HIP) at 920°C for 120 minutes, 100 MPa.
T Additive Manufacturing Ltd, Product Data Sheets / Available at: www.3t- m.com, visited 2019	Stress relieved at 800°C for 2 hours in a vacuum furnace with specimens on build plate.
Aeltio, Product Data Sheets / Available at: https://meltio3d.com/, visited 2022	Stress Relief - Heat up to 730°C in 2 h - Hold at 730°C during 2 h - Cool down to Ambient T* in 1 h 50 min

Fig.15. Heat treatment used for the alloy Ti6Al4V used in Additive Manufacturing

The database gives us details concerning the heat treatment used for the alloy Ti6Al4V used in Additive Manufacturing, as in the figure 15.

А	s powdered;	Spherical Shape a	nd a few satellites; SEM image
GENERAL INFORM	MATION		
As powdered			
Microstructure		Spherical Shape and a fe	w satellites
Comment		SEM image	
	H	2	

Fig.16. Metallography details for Ti6Al4V powders used in Additive Manufacturing









Total Materia gives us details concerning the metallography of the alloy Ti6Al4V used in Additive Manufacturing, as in the figure 16 and the tribology is given in figure 18. In figure 17 are presented the similar materials with the same composition existing on the market.

	The material does not have direct properties. Similar materials that have these properties are lis Click on the material to view properties.	ited in the table below.		😰 ADD TO MATERIAL LIST BUILDER 🛛 👉 FORM		
Result	t(s) found: 156			ADD TO MATERIAL LIST BUILDER	ARD 10	
=+	MATERIAL	STANDARD	COUNTRY / PRODUCER	EQUIVALENCE CATEGORY		C
1	S TI 6408J (TIAl6V4AJ)	SIE	Japan	Composition 100%	→←	C
2	TA6V	AFNOR NF	France	Composition 100%	→←	
3	Ti 6Al-4V Grade 5	PROPRIETARY	Allegheny Technologies Incorporated; Ulbrich Stainless Steel	Composition 100%	→←	C
4	Ti-6Al-4V	ONORM	Austria	Composition 100%	→←	C
5	Ti-6Al-4V	NBN	Belgium	Composition 100%	→←	C
6	Ti-6Al-4V	NBR	Brazil	Composition 100%	→←	C
7	Ti-6Al-4V	BDS	Bulgaria	Composition 100%	→←	C
8	Ti-6Al-4V	CSN	Czech Republic	Composition 100%	→←	5
9	Ti-6Al-4V	EN	European Union	Composition 100%	→←	Ģ
10	Ti-6Al-4V	SFS	Finland	Composition 100%	→←	(

Fig.17. Similar Materials with the same composition existing on the market

Tribology				
CONDITIONS (3)				
Tested Material - Heat treatment: As Built				
O Tested Material - General comment: Standard Grade				
O Tested Material - General comment: Performance Grade				
SELECTED CONDITION Tested Material Heat treatment: As Built				
Tested Material				
PROPERTY	T(°C)	VALUE	UNIT	NOTE
Surface Roughness		10 80	µm µm	Ra Rz
Reference for the selected material and condition				
1 Airbus Apworks GmbH, Product Data Sheets / Available at: www.apworks.de, visited 2018				
All references for the selected material				
1 Airbus Apworks GmbH, Product Data Sheets / Available at: www.apworks.de, visited 2018				
2 Materialise, Product Data Sheets / Available at: www.materialise.com, visited Oct-2019				

Fig.18. Tribology properties of Ti6Al4V used in Additive Manufacturing











For welding and brazing are given different variants similar alloy of Ti, as in figure 19. In the figure 20, it is presented the stress strain diagram for Ti6Al4V used in Electron Beam Melting (EBM). The fatigue data is given in the figure 21, by ARCAM company.

weldi	Joints ng * Brazing *			
	The material does not have direct properties. Similar materials that have these properties are listed in Click on the material to view properties. t(s) found: 50	the table below.		🖉 add to material litt duelder 🤟
=+	MATERIAL	STANDARD	COUNTRY / PRODUCER	EQUIVALENCE CATEGORY
1	YTAW 640 E	KS	Korea	Composition 100%
2	AB-1	SAE	United States	Other sources
3	B 265 Grade 5	ASTM	United States	Other sources
4	B 265 Grade Ti-6Al-4V	ASTM	United States	Other sources
5	ERTI-5	AWS	United States	Other sources
6	S Ti 6402	ONORM	Austria	Other sources
7	S Ti 6402	NBN	Belgium	Other sources
8	S Ti 6402	BDS	Bulgaria	Other sources
9	S Ti 6402	CSN	Czech Republic	Other sources
10	S Tİ 6402	EN	European Union	Other sources

Fig.19. Different variants similar alloy of Ti, used in welding and in brazing

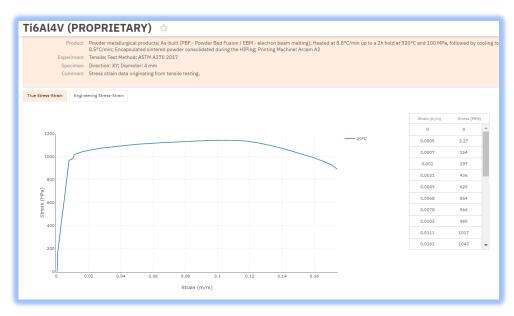


Fig.20. Stress strain diagram for Ti6Al4V used in Electron Beam Melting (EBM)









MECHANICAL PROPERTIES		IW PHYSICAL PROPERTIES	CROSS REFEREN	NCING		TRACKER
Yield Strength, Rp0.2 744 – 111 Tensile Strength 843 – 128 Elongation, A 3.5 – 18 9	2.4 MPa	Modulus of Elasticity 100 – 124 GPa Dentity 2-2.5 kg/dm³ Coefficient of Thermal Expansion (CTE) 7.6 – 7.9 10 ⁶ /°C	185 All	0 Official	103 Other	Last update 2022-12 Mechanical Properties; Physical Properties; Composition; He Treatment
Strain Life Parameters * Stress Life F	arameters 1					
SELECTED CONDITION	allurgical products:	As-built (PBF - Powder Bed Fusion / EBM - electron beam r	nelting): Hot Isostatic P	Pressing (HIP) a	t 920°C for 120 min	ites. 100 MPa
Experiment Rotating be	am; Test temperatur	e: 20 °C	ioning), not ioconation	10000118 (1117) 0		
Comment Number of	,					
		le Strength: 1020 MPa; Elongation, A: 14 %				
		le Strength: 1020 MPa; Elongation, A: 14 % Specimen	Fatigue strength (Mi	Pa)		Number of cycles

Fig.21. Fatigue data given for Ti6Al4V used in Electron Beam Melting (EBM)

Equivalents Finder			
▼ PROPERTIES			
≡+ Add property			
Mechanical Properties	Brinell Hardness (HB)	Elongation, A (%)	Reduction of Area (%)
Physical Properties	Rockwell Hardness (HR)	Tensile Strength (MPa)	Vickers Hardness (HV)
Chemical Composition ⑦	Yield Strength, Rp0.2 (MPa)		

Fig.22. Equivalents finder

The database permits us to find equivalents finder in function of the Brinell hardness [HB], Rockwell hardness [HR], Yield strength Rp0,2 [MPa], elongation A [%], tensile strength [MPa], reduction of area [%], Vickers hardness [HV], modulus of elasticity [GPa], density [kg/dm³], melting temperature [°C], coefficient of thermal expansion (CTE) (10⁻⁶/°C) or chemical composition, as in figure 22.

Total Materia give us the material description for the alloy Ti6Al4V used in Electron Beam Melting (EBM), specifying the applications domain, in the case of powder, is given the particles size distribution, additive laser manufacturing systems type that used this powder, the biocompatibility, as in figure 23.









	Material Description		Application	It is used in a variety of medical applications which require high strength.
Material Do	escription		Source	tiğbal Melal (part di Hilgenis Grupp Company)
			Comment	30 printy (Addive narukaturig) - Bode Jeding Nature 107 1200
Source	Meltio		Sturce	ndune.unr.com
Comment	3D printing (Additive manufacturing) - Direct Energy Deposition (DED) Machine: Metlio M450 Titanium alloy with high strength, low density, high fracture toughness, excellent corrosion resistance and superior biocompatibility		Connert	Thronfog Malline translation of - Floor Head Law Schweg DMLS Throndo floot thran the secolar metabodic propriate with we proceeder and/or ancione sections. Analizabile in Standard Schwarter Martinese Statut.
Application	Tools and prot	otypes, aerospace, marine, chemical	Application	Aeronaufics, Functional prototypes, solid end-use parts, medical devices and space parts
Source	Optimal Mater	rial Technology CO.,Ltd	Source	kran Ni
	1 0 -	ddiiwe manufacturing) - Selective Laser Melting (SLM) ept Laser M2, EOS M 280.	Connert	30 princip Addine mandaching) Theirun alay with behigt steeping, port-machinalitio, low weight adio and outstanding convoion existance.
Comment	Particle size distribution: 15-53 µm. Hall flow rate: 36 s/S0g		Application	Typically used for check manufacturing of parts and prototypes for racing and sensorae industry. Biomechanical applications, such as implants and prodifieds, marine applications, chemical industry, gas turbine
			Source	Sintaria
Source			Comment	. 20 printig Holdrive navokazung – Vienz Henzi Laues Streinig (IMAS) Carroson resistance, streigh, henpuetaur esistance and weight reduction.
	3D printing (Additive manufacturing) - Selective Laser Melting (SLM), Electron Beam Melting (EBM) Particle size range: 15-45 µm.		Source	Smithey sp. z na.
Particle size range: 13-40 pm. Particle size distribution d ₈₀ < 30 pm. Liquidhy Flowability: ≤ 40s.		stribution d ₅₀ : ≤ 30 µm.	Connert	30 yrinig (Adhine navlachnig, Sakatie Laer Mahry (SUV) Tabian alay puwla:
Source	Proto Labs, In	c.	Source	AUREUS APINORIES GINÈH
Comment		difive manufacturing) - Direct Metal Laser Sintering (DMLS) operties of Ti6Al4V are comparable to wrought titanium for tensile strength, elongation, and hardness.	Connert	33 printig Rétrie nandracting - Saer André Gél Addinés ages Readracting RAV) Light néght chiann din proké. Seallert netaraic properies and consist ne sairance. Smálet sel fróðeset fmýl 1.0
Application	It is used in a v	variety of medical applications which require high strength.	Application	Aerospace, motor racing and also for the production of biomedical implants.
ource		Heraeus Additive Manufacturing GmbH		
Comment		3D printing (Additive manufacturing) - Laser Powder Bed Fusi High strength titanium alloy with low weight, good biocompat Particle Size Distribution (µm): 15-45 and 15-53		
pplication		Medical, aerospace and automotive		
ource		3T Additive Manufacturing Ltd (former 3T RPD Ltd.)		
Comment		3D printing (Additive manufacturing) - Direct Metal Laser Sint Machine: EOSINT M290, EOSINT M280, EOSINT M400, EOSI Titanium alloy powder. Corrosion resistance, lightweight, bioc	NT M40	00-4
pplication		Prototyping, engineering, biomedical implants, small series p	roducti	on
ource		Vday Additive Manufacturing Technology Co., Ltd.		
omment		3D printing (Additive manufacturing) - Selective Laser Melting Titanium alloy powder. High strength to weight ratio, good me		Electron Beam Melting (EBM) al properties, excellent corrosion resistance, good biocompatibility
plication		Medical implants, automotive, aerospace, mold, energy and p		1

Fig.23. Material Description - for Ti6Al4V used in Electron Beam Melting (EBM)

In the figure 24, it is presented how can discovery the material type, choosing the domain for Brinell Hardness [HB], for the temperature 0-30°C on X axis, meaning from 500 to 800, and the compression modulus [GPa], for the temperature 0-30°C, from 100-124, and are given 2 group types, ferrous alloys and nonferrous alloy. In figure 25, the database permits us to see the material properties if it is known the standard ASTM, the standard number.









SELECT PROPERTIES																0	Full scree
l-axist		600	-								-						
Drinell Hardness (HD)	× •	500															
0-30°C	× •	(Pdg) 400															
om To 500 800 💭 Log		100 Kodut															
axis: Compression Modulus (GPa))- 50°C	* •	100															
		0	ò	50 0	0 15	200	250	800	350	400 451	500	550	650 650	700	750 8	800 8	50 90
124 Dog										Brinell Hard	vess (†16)				←	FORMULARE TO	
.00 124 🔘 Log		Maserial	iroups				Brin	oll Hardness	(HB)	Sninell Hard	vess (116)	Compr	ession Modulus (G	Paj	¢	FORWARD 10	
124 Dog		Mazeria (irosps Ferrous Al	loys			Brin 20 -		(HB)	Srinell Hard	ness (HB)	Comps 70 - 2		Paj	¢	FORMULEE TO	
124 Dog		Moserial C						000	(HB)	Brinell Hard	vess (HB)		14	Pa)	t	FORMARE TO	
100 124 💭 Log		Maserial > S > S	Ferrous Al				20 -	000	(HB)	Brinell Hard	vess (HD)	70 - 2	14 08		← vați Wir		0

Fig.24. Material discovery

⊷ ←		Quick Search Ad	Ivanced Search Standard list Ma	iterial Discovery	
Standard list					
All	~ c46	ICS Numbe	<u>8</u>	Standard Description	Q Search Clear
esult(s) found: 1				M - M	MATERIALS \mathbf{D} - DIMENSIONS \mathbf{C} - COATINGS \mathbf{R} - REL
					1 to 1 of 1 . IC is pe
# STANDARD	STANDARD NUMBER	LAST VERSION	ICS NUMBER	STATUS	M D C
ASTM 1	C455 Chrome-Magnesia, Magnesia-Chrome, and Magnesia Brick	2007	81.080	Responsed 2018	M D G

Fig.25. Standard list

3. Total Materia database – Search algorithms used for identification the unknown metallic materials

For the chemical composition Co 54,31 %, Cr 23,08 %, Mo 11,12 %, W 7,85 %, Si 3,35 % and Mn, Fe < 0,1, using the algorithms of the Total Materia database, it will identify the material with this chemical composition, as in the figures 26 and 27.

ieneral Information			
hemical Composition (%)	Select	¥	
techanical Properties			
hysical Properties			
pecial Search			

Fig.26. Algorithms used for identification the unknown materials











Advanced Search - Add criteria			
General Information			
Chemical Composition (%)	Select		~
Mechanical Properties	Co: 50	- 55	🗌 Not Allowed 🕕 🗙
Physical Properties			
Special Search	Cr: 20	- 24	🗌 Not Allowed 🕚 🗙
	Mo: 10	- 12	🗌 Not Allowed 🚯 🗙
	W: 5	- 10	🗌 Not Allowed 🚯 🗙
	Si: 2	- 4	🗌 Not Allowed 🕕 🗙
	Mn: 0	- 1	🗌 Not Allowed 🕕 🗙
	Fe: 0	- 1	🗌 Not Allowed 🕕 🗙
=+ ADD TO SEARCH CANCEL			

Fig.27. Chemical composition selection

When we want to change the chemical composition, it must click on clear.

_				
Che	mical Composition (%): Co: 45 – 60 AND Cr: 20 – 30 X OR 🖛 Add se			
	Add search criteria	Al-	ND	
-				
C	SEARCH CLEAR			
C	SEARCH CLEAR			
sult	t(s) found: 91			
	MATERIAL	STANDARD	COUNTRY / PRODUCER	CLASSIFICATION
	MATERIAL 2.4778	STANDARD AFNOR NF	COUNTRY / PRODUCER France	
				Nonferrous Alloys / C
	2.4778	AFNOR NF	France	Nonferrous Alloys / C
	2.4778 2.4778	AFNOR NF ASRO	France Romania	Nonferrous Alloys / C Nonferrous Alloys / C Nonferrous Alloys / C
	2.4778 2.4778 2.4778	AFNOR NF ASRO B.S.	France Romania Uniked Kingdom	Nonferrous Alloys / C Nonferrous Alloys / C Nonferrous Alloys / C Nonferrous Alloys / C
	2.4778 2.4778 2.4778 2.4778	AFNGN NF ASRO 8.5. 805	France Romania United Kingdom Bulgaria	Nonferrous Alloys / C
	2.4778 2.4778 2.4778 2.4778 2.4778	AFNOR NF ASRO B.S. BDS CSN	France Romania United Kingdom Bulgaria Creeh Republic	Nonferrous Alloys / C Nonferrous Alloys / C
	2.4778 2.4778 2.4778 2.4778 2.4778 2.4778	AFNOR NF ASRO B.S. BDS CSN DN	Prance Romania United Kingdom Bulgaria Czech Republic Germany	CLASSIFICATION Nonferrous Alloys / C Nonferrous Alloys / C

Fig.28. Co-Cr alloy results that have the respective chemical composition

In the figure 28 are presented the Co-Cr alloy results that have the respective chemical composition.











The first is the material 2.4778, standard AFNOR NF, France and if we give click, can know the mechanical properties, the chemical composition, and its applications. In the figure 29 is presented the determination of the material: CoCr28 and their properties. The material description is presented in the figure 30.

2.4778 & Material Designation <u>G-CoCr28</u> Country/Standard France / AFNOR NF Material group Nonferrous Alloys / Cobalt					
MECHANICAL PROPERTIES Yield Strength, Rp0.2 2 235 MPa Tensile Strength 2490 MPa Elongation, A 26 %	CAL PROPERTIES Density 8.1 kg/dm ¹ ermai Conductivity 8.5 W/(m*C) Heat Capacity 500 J/(kg*C)	⊃⊂ CROSS RE 41 All	FERENCING O Official	0 Other	TRACKER
SYNTHETIC VIEW DETAILS VIEW					
TEMPERATURE			PROPE	RTY / VALUE	
□ > 300°C		YIE	D STRENGTH, RP0.2	≥ 235 MPa	
□ 100 - 300°C			TENSILE STRENGTH	≥ 490 MPa	
□ 30 - 100°C			ELONGATION, A	≥6%	
□ < 0°C					

Fig.29. Determination of the material: CoCr28 and their properties

.4778	☆				=
	ion <u>G-CoCr28</u> ard France / AFNOR NF oup Nonferrous Alloys / Cobalt				
Ф месна	NICAL PROPERTIES	IN PHYSICAL PROPERTIES	>C CROSS REFERENCING	TRACKER	ć
Yiel	d Strength, Rø0.2 ≥235 MPa Tensile Strength ≥490 MPa Elongation, A ≥6 %	Density 8.3 kg/dm ⁴ Thermal Conductivity 8.5 W/(m ⁴ C) Heat Capacity 500 J/(kg ⁴ C)	41 0 0 Alt Official Other	Lest update 2022-09 Composition	
aterial D	escription				
ource	NF EN 10295: 2002 / Heat resis	tant steel castings			
omment	Cobalt base alloy				
oplication		ssure applications) above 600°C. The maximum applicable ope temperature in air is 1100°C.	rating temperature 1200°C is valid for oxidation resistance in cla	ean natural air. In other atmosphere, this temper	ature can differ widely.

Fig.30. Material description of CoCr28











4. Total Materia database – polymers, ceramics and composite materials

Total Materia database is used too for the polymers (Fig.31), ceramics and composite materials.

The database given 125 results of PLA types, as in the figure 32.

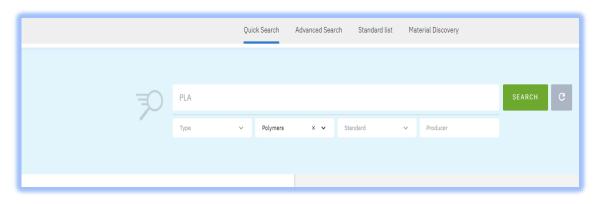


Fig.31. Total Materia database for the polymers

Resu	Result() found 125					
=+	MATERIAL	STANDARD	COUNTRY / PRODUCER	CLASSIFICATION		
1	PLA	GENERIC		Polymers / Plastics, thermoplasts / Biopolymers (CA, CAB, PLA) / PLA 3D Materials		
2	PLA++	PROPRIETARY	Breathe-3DP	Polymers / Plastics, thermoplasts / Biopolymers (CA, CAB, PLA) / PLA 3D Materials		
3	PLA Crystal Clear	PROPRIETARY	Fillamentum	Polymers / Plastics, thermoplasts / Biopolymers (CA, CAB, PLA) / PLA 3D Materials		
4	PLA Extrafill	PROPRIETARY	Fillamentum	Polymers / Plastics, thermoplasts / Biopolymers (CA, CAB, PLA) / PLA 3D Materials		
5	PLA Filament	PROPRIETARY	Filament PM	Polymers / Plastics, thermoplasts / Biopolymers (CA, CAB, PLA) / PLA 3D Materials		
6	PLA Plus ProSpeed	PROPRIETARY	Rosa 3D	Polymers / Plastics, thermoplasts / Biopolymers (CA, CAB, PLA) / PLA 3D Materials		
7	PLA Premium Filament	PROPRIETARY	Airwolf 3D	Polymers / Plastics, thermoplasts / Biopolymers (CA, CAB, PLA) / PLA 3D Materials		
8	PLA Prografen color	PROPRJETARY	Advanced Graphene Products	Polymers / Plastics, thermoplasts / Biopolymers (CA, CAB, PLA) / PLA 3D Materials		

Fig.32. 125 results of PLA types existing on the database

In figure 33, are presented the mechanical properties of PLA crystal clear.

Database give us the manufacturing processes of PLA crystal clear, such as 3D Printing and temperature used in the manufacturing processes, as in figure 34.









ountry/Standard PROPRIETARY				
Producer Fillamentum				
Material group Polymers / Plastics, thermoplasts / Bio 3D Materials	polymers (CA, CAB, PLA) / PLA			
MECHANICAL PROPERTIES	₩ PHYSICAL PROPERTIES	∝ CROSS REFERENCING		TRACKER
Tensile Strength 50 MPa	Modulus of Elasticity 3.5 GPa	No cross-referenced materials available		Last update 2021-08
Tensile Strain ≤ 5 %	Density 1.24 kg/dm ^s	Use <u>Equivalents Finder</u> to search for similar	materials	Mechanical Properties; Physical Properties; Manufacturing
Impact Strength $\leq 5 \text{ kJ/m}^2$	Glass Tran. Temp. 55 – 60 °C			Processes
THETIC VIEW DETAILS VIEW				
THETIC VIEW DETAILS VIEW		PROPERT	y / VALUE	
		PROPERT TENSILE STRENGTH		III view details
TEMPERATURE			50 MPa	II <u>view details</u> III <u>view details</u>
TEMPERATURE > 300°C 100 - 300°C 30 - 100°C		TENSILE STRENGTH	50 MPa ≤5 %	
TEMPERATURE > 300°C 100 - 300°C		TENSILE STRENGTH TENSILE STRAIN TENSILE STRAIN AT BREAK	50 MPa ≤5 % ≤5 %	II <u>view details</u> III <u>view details</u>
TEMPERATURE > 300°C 100 - 300°C 30 - 100°C		TENSILE STRENGTH	50 MPa ≤5 % ≤5 %	III <u>view details</u>

Fig.33. Mechanical properties of PLA crystal clear

Manufacturing Processes		
PROPERTY	VALUE	UNIT
3D printing machine settings Reference: Fillamentum, Product Data Sheets / Available at: www.fillamen	ntum.com, visited 2021	
Heated Bed Temperature	50 - 60	°C
Printing Temperature	210 - 230	°C
Reference for the selected material and condition 1 Fillamentum, Product Data Sheets / Available at: www.fillamentum.com, visited 20	221	

Fig.34. Manufacturing processes of PLA crystal clear

In the figure 35 is realized the material description for PLA materials, being specify that it is used in Fused Deposition Modeling (FDM) process.









PLA Cry	ystal Clear 🛛 🕁			=+
	dard PROPRIETARY ucer Fillamentum			
Material gr	oup Polymers / Plastics, thermoplasts / Biopolyme 3D Materials	ers (CA, CAB, PLA) / PLA		
О месни	ANICAL PROPERTIES	₩ PHYSICAL PROPERTIES	CROSS REFERENCING	TRACKER
	Tensile Strength 50 MPa Tensile Strain ≤5 % Impact Strength ≤5 kJ/m*	Modulus of Elasticity 3.5 GPa Density 3.24 Kg/dm³ Glass Tran. Temp. 55 – 60 °C	No cross-referenced materials evailable Use <u>Equivalents Finder</u> to search for similar materials	Last update 2021-08 Mechanical Properties; Physical Properties; Manufacturi Processes
aterial [Description			
urce	Fillamentum			
	Polylactic acid (PLA), unreinforced; good Appearance: transparent, available in blu	chemical resistance to oils and greases, BPA free, styrene f Je, green, orange and purple colors	ree	
omment				
omment	Filament			

Fig.35. Material description for PLA filament

For ceramics, by example Hap, we obtain the results as in the figure 36.

НАр							SEARCH
Туре	~	Ceramics	× •	Standard	~	Producer	

Fig.36. Ceramic search

P	P Quick Search						
You a	re currently viewing results which contain part of your search criteria a	s part of the material designation.					
If you	a would like to view more possible matches for your search, please <u>clic</u>	chere.					
Resul	Result() fourd; 6						
m +	MATERIAL	STANDARD	COUNTRY / PRODUCER	CLASSIFICATION			
1	3DMIX HAP	PROPRIETARY	3DCeram	Ceramics / Technical ceramics / Other / Not specified (Z) 3D Materials			
2	Shapal - M	PROPRIETARY	CoorsTek, Inc.	Ceramics / Technical ceramics / Nitrides / Aluminum nitride (AIN)			
3	Shapal Hi M soft	PROPRIETARY	Tokuyama Corporation	Ceramics / Technical ceramics / Nitrides / Aluminum nitride (AIN)			
4	Shapal SH-15	PROPRIETARY	Tokuyama Corporation	Ceramics / Technical ceramics / Nitrides / Aluminum nitride (AIN)			
5	Shapal SH-30	PROPRIETARY	Tokuyama Corporation	Ceramics / Technical ceramics / Nitrides / Aluminum nitride (AIN)			
6	Shapal SH-50	PROPRIETARY	Tokuyama Corporation	Ceramics / Technical ceramics / Nitrides / Aluminum nitride (AIN)			

Fig.37. HAp variants existing on the database

In the figure 37, are given the Hap variants existing on the database, their producers, country and standards. In the figure 38 are given the mechanical properties of Hap.









3DMIX HAP 🕁		
Country/Standard PROPRIETARY		
Producer 3DCeram		
Material group Ceramics / Technical ceramics / Other / Not s 3D Materials	pecified (Z)	
MECHANICAL PROPERTIES	₩ PHYSICAL PROPERTIES	CROSS REFERENCING
Modulus of Rupture 107 MPa	Density ≥ 1.5 kg/dm³ Grain Size 2 E-03 mm	No cross-referenced materials available Use <u>Equivalents Finder</u> to search for similar materials
SYNTHETIC VIEW DETAILS VIEW		
TEMPERATURE		PROPERTY / VALUE
□ > 300°C		MODULUS OF RUPTURE 107 MPa
□ 100-300°C		
🗌 30 - 100°C		
☑ 0 - 30°C		
⊃°0> □		
-		

Fig.38. Mechanical properties of HAp

Material Description				
Source	3DCeram			
Comment	Hydroxyapatite (HAP), calcium phosphate; excellent bioactivity, good osseointegration Ca/P ratio = 1.65 - 1.82			
Application	For tibial osteotomy wedges, intervertebral cages, cranial implants, bone substitutes, spine implants, orthopedic implants			
Form	Paste			
Processing	3D printing (Additive manufacturing) - Stereolithography (SLA), Sintering Machine: Ceramaker C900, Ceramaker C100			

Fig.39. Material description of HAp

Hap is used in additive manufacturing in SLS and in SLA, using Ceramaker C900 or Ceramaker C100, the platform gives us inclusive information about the manufacturing systems that used this material. Hydroxyapatite is used as paste in the additive manufacturing process to obtain tibial osteotomy wedges, intervertebral cages, cranial implants, bone substitutes, spine implants or orthopaedic implants, as in the figure 39











Concerning the composite materials, by example plywood, the database give us 3 results, such in the figures 40 and 41.

					SEARCH C
~	Composites × 🗸	Standard	~	Producer	
	Q Search				
	Ferrous Alloys Nonferrous Alloys				
	 Polymers Ceramics Composites 	ок	80	20K	25M
	Cements Honeycombs Foams	R OF IALS	STANDARD ORGANIZATIONS	DATA SOURCES	DATA POINTS
		Q Search → Ferrous Alloys → Nonferrous Alloys → Polymers → Ceramics → Composites → Fibers → Cements → Honeycombs	Q Search > Ferrous Alloys > Nonferrous Alloys > Polymers Ceramics OK > Fibers > Cements > Honeycombs	Q Search > Ferrous Alloys > Nonferrous Alloys > Polymers > Ceramics > Composites > Cements > Honeycombs * Honeycombs	Search → Ferrous Alloys → Nonferrous Alloys → Polymers → Ceramics > Composites OK 80 20K → Fibers → Cements → Honeycombs

Fig.40. Quick search of plywood

Resul	t(s) found: 3			
=+	MATERIAL	STANDARD	COUNTRY / PRODUCER	CLASSIFICATION
1	Class I	GB	China	Wood / Wood-based panels / Plywood
2	Class II	GB	China	Wood / Wood-based panels / Plywood
3	Class III	GB	China	Wood / Wood-based panels / Plywood

Fig.41. For composite plywood – 3 results

Class I ☆					≡+
Country/Standard China / GB Material group Wood / Wood-based panels / Plywood					
MECHANICAL PROPERTIES	IN PHYSIC	CAL PROPERTIES	→ CROSS REFERENCING		TRACKER
Flexural Strength 12-32 MPa Bond Strength 20.7 MPa	Mo	dulus of Elasticity 2 – 5.5 GPa Water Content 5 – 14 %	No cross-referenced materials available Use <u>Epulvalents Finder</u> to search for simile	r materials	Last update 2018-05 Mechanical Properties, Physical Properties
SYNTHETIC VIEW ODDETAILS VIEW					
TEMPERATURE			PROPER	RTY / VALUE	
□ > 300°C			FLEXURAL STRENGTH	12 – 32 MPa	III <u>view details</u>
□ 100 - 300°C			BOND STRENGTH	≥0.7 MPa	III view details
🗆 30 - 100°C					
🗹 0 - 30°C					
□ < 0°C					
•					

Fig.42. Mechanical properties of plywood class I











In the figure 42 are presented the mechanical properties of plywood class I. In the figure 43 is presented the material description of plywood class I, that can be used in outdoor environment.

Material Description			
Source	GB/T 9846: 2015 / Plywood for general use		
Comment	Plywood which can pass boiling test and can be used in outdoor environment		

Fig.43. Material description of plywood class I

5. Conclusions

In the last years, the materials developed very much, appeared different news materials with very interesting properties realized by different world companies, that can be used in Additive Manufacturing and in other manufacturing domain to realize medical parts or for industrial domain and grace to this database, all materials developed are introduced in this platform, giving us the possibility to choose, the chemical composition, the mechanical properties, or using the search algorithms, finding the unknown material, in function of the chemical or mechanical properties.

The implications of the present research would be interesting for the manufacture by Additive Manufacturing different medical parts, using different materials using the database Total Materia, or others to know the mechanical and chemical properties that are very important to establish the manufacturing parameters and manufacturing systems and tools.

References

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