Celulose e nanocelulose UEL

nanotecnologia que cresce

Cesar Tischer, Julho/2021

Universidade Estadual de Londrina

- >1600 professores pesquisadores em grupos de pesquisa certificados
- 25 mil estudantes graduação

Universidade Estadual de Londrina

- 4.500 pós-graduação
- 300 grupos de pesquisa certificados no CNPq
- e cerca de 1800 artigos científicos publicados em todas as áreas



agro valley Londrina

inte gra

QUÍMICO & MATERIAIS

PROPLAN

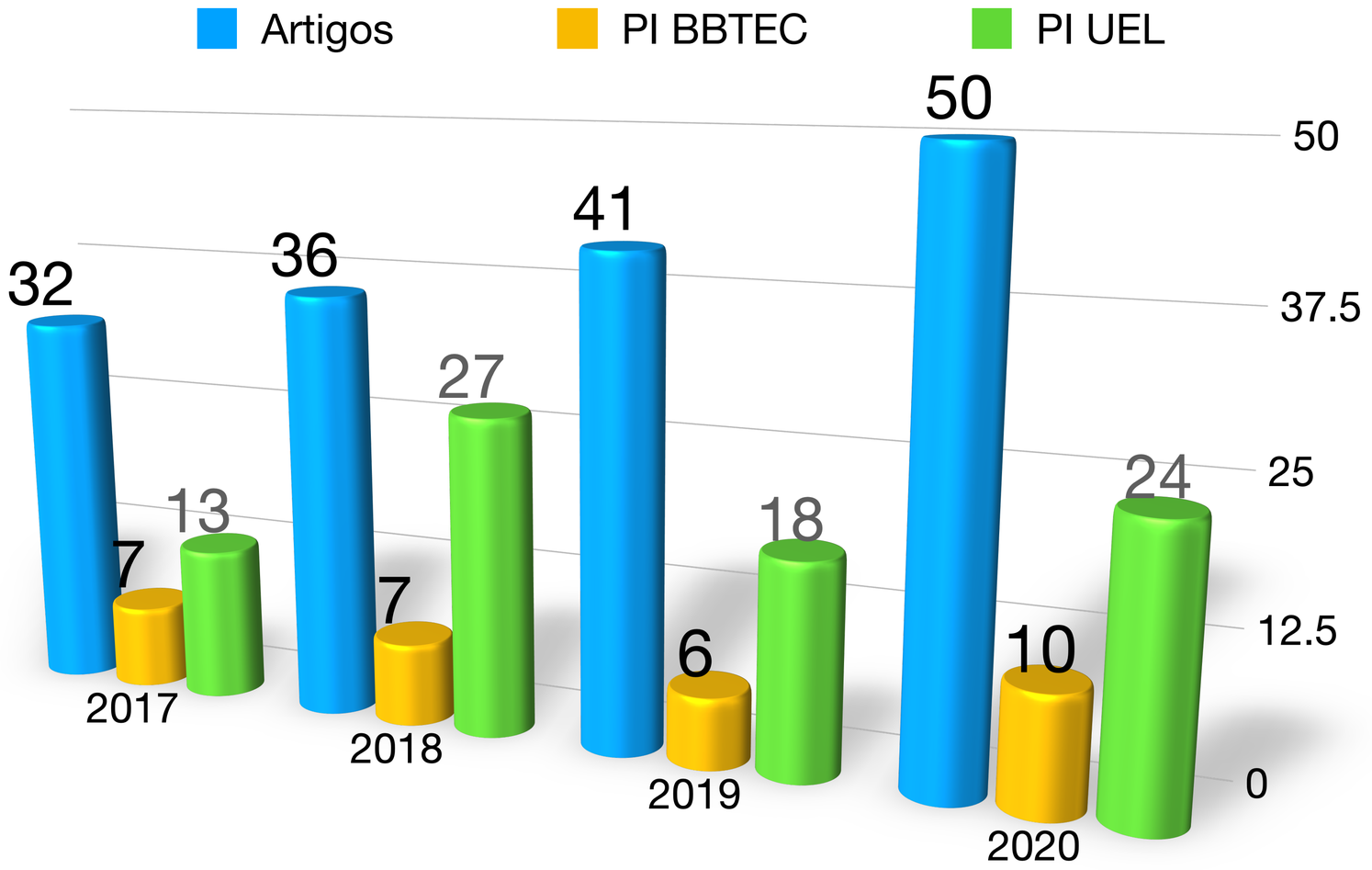
Universidade Estadual de Londrina

Intuel

Incubadora Internacional de Empresas de Base Tecnológica da UEL

Registro de Propriedade Intelectual

- A UEL, entre as 50 instituições brasileiras que mais registraram patentes em 2019;
- Registro de patentes:
  - 2017: 13
  - 2018: 27
  - 2019: 18
  - 2020: 24
  - 2021: 19



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    - 2017: 13
    - 2018: 27
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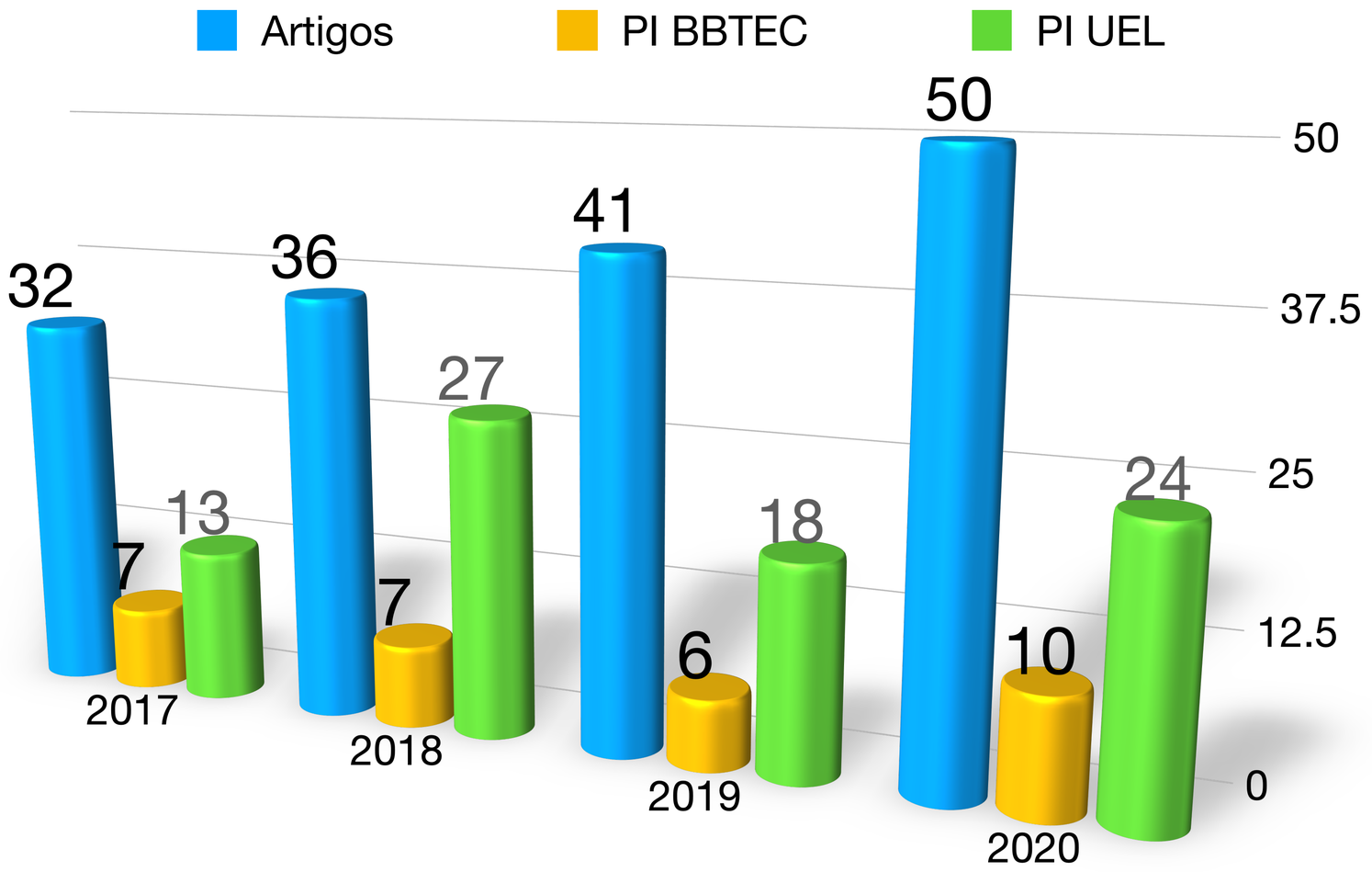


- Pós-Graduação em Biotecnologia

razão art/pat	4.6	5.1	6.8	5.0
% pate Bbtec/UEL	35	21	25	29

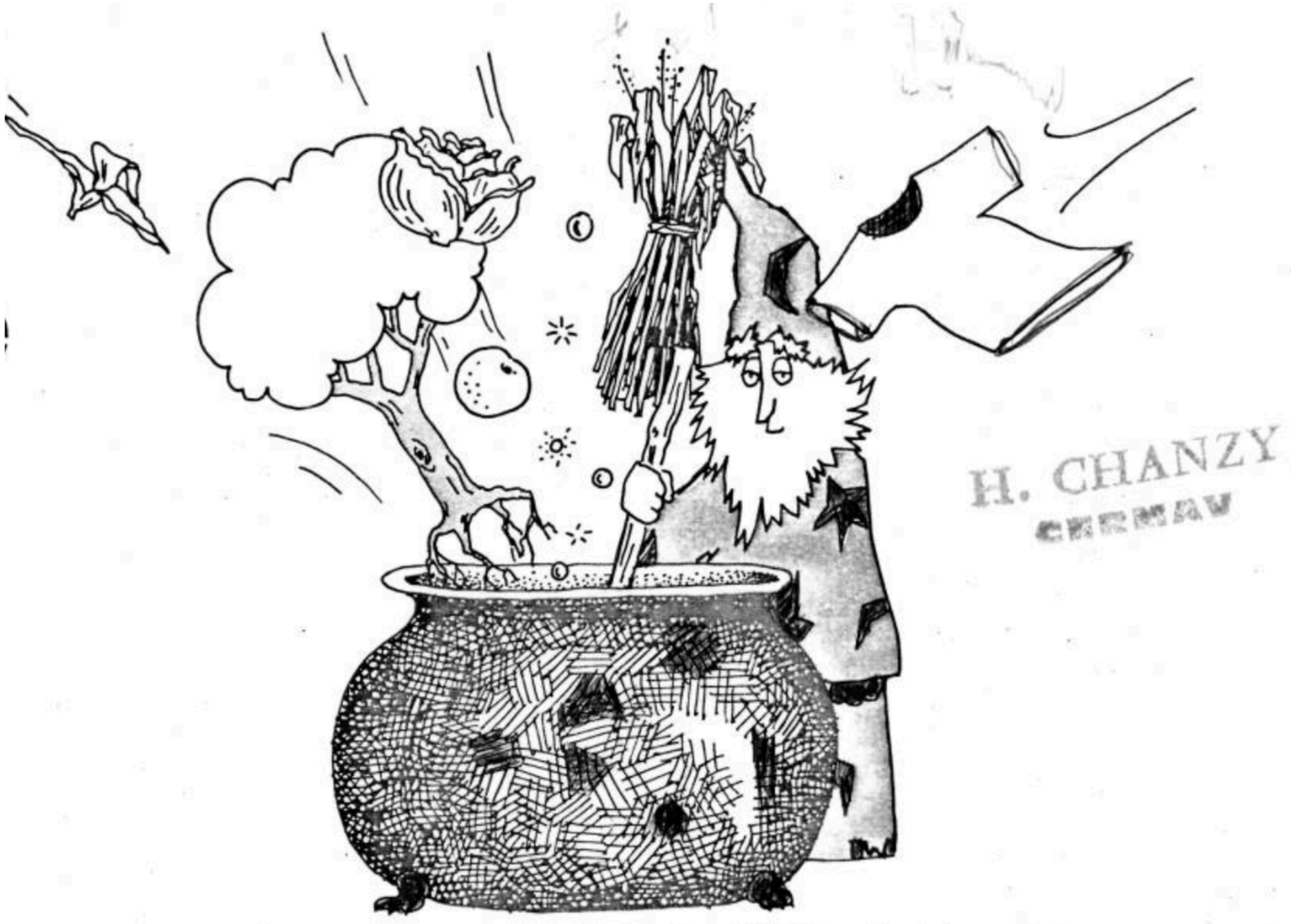
2019, grupos publicando em nanocelulose

Jacinto&Spinacé.
Mapping of the Brazilian Groups Studying Nanocellulose
JRM (2019) 7(5)

Position	Group/Leader	Publications
1	Unesp*-Campus Araraquara / Ribeiro, SJL	57
2	Embrapa#-Unit São Carlos / Mattoso, LHC	39
3	UFMG*/Pereira, FV	32
4	UFSC*/Porto, LM	20
5	Embrapa#-Unit Fortaleza / Rosa, MD	18
6	UFU*/Pasquini, D	17
	UFPR*/Sierakowski, MR	17
7	Unesp*-Campus Araraquara / Guastaldi, AC	16
8	Unesp*-Campus Botucatu / Leao, AL	13
	Uniara§/Trovatti, E	13
9	USP*-Campus São Carlos / Carvalho, AJF	12
	Embrapa#-Unit Colombo / Magalhaes, WLE	12
	UEM*/Rubira, AF	12
	UCS§/Zattera, AJ	12
10	UEL*/Tischer, CA	11
	UFLA*/Tonoli, GHD	11

*Universidade pública; #Empresa pública; § Universidade privada

por que pesquisar celulose



por que pesquisar celulose

1928, Umberto Pomilio:

… Ferro e cellulose são igualmente isolados da natureza até um estado de grande pureza.

… O ferro possui qualidade não oferecidas por outros metais, e a celulose é igualmente indispensável e raramente substituível por outras substâncias orgânicas.

… são produzidos na mesma proporção, e assim como o consumo do ferro é um índice da mecanização de uma nação, a celulose é a medida do seus status intelectual.

- http://celluloseether.com/wp-content/uploads/2018/05/Introduction_June-2016.pdf
- https://onlinelibrary.wiley.com/doi/abs/10.1002/jctb.5000470402

MESSEL MEMORIAL CONTRIBUTION

INDUSTRIAL RESEARCHES ON THE PRODUCTION OF PURE CELLULOSE: QUALITATIVE ASPECTS OF THE INDUSTRIAL PROBLEM OF CELLULOSE

By UMBERTO POMILIO

Cellulose has gained such a position as a raw material for various important industries that it has become one of the chief products which are indispensable to progress; indeed, it characterises modern civilisation. That this importance has been realised by scientific men is shown by the fact that the chemical and technical papers on cellulose which have been published during the last 50 years are estimated, as Cross stated two years ago in a lecture at Oslo, to number some 40,000.

A comparison, which is perhaps unusual, induces us to place cellulose in the field of the organic industries at the level of importance which iron has reached in metallurgy. Iron can be isolated from its oxides, and nowadays industrial cellulose is mainly obtained from suitable plants; neither is easily obtained in a state of great purity. If iron possesses qualities not offered by other metals, cellulose is equally indispensable and rarely replaceable by other organic substances. The annual production of one or the other is very great and comparable in quantity, and if the consumption of iron is an index of the mechanical civilisation of the nations, that of cellulose and paper gives us the measure of their intellectual status.

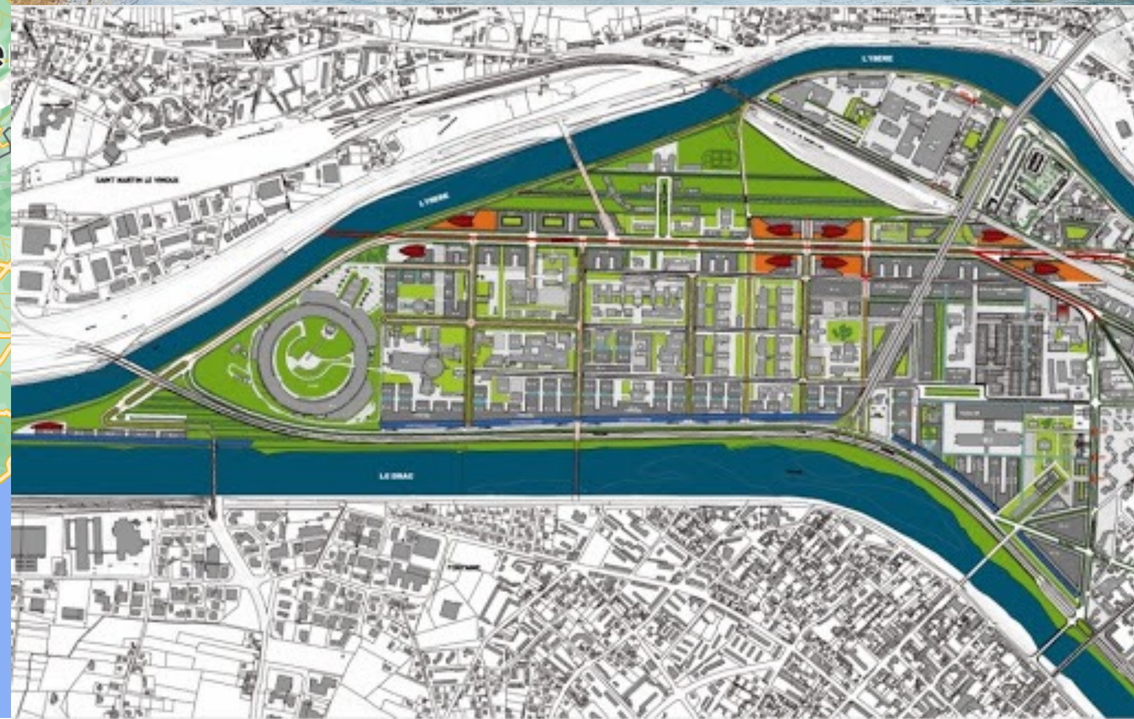

battery
supercapacitor
heavy metal ion
electrode
insulation
adsorbent
contaminant
selectivity
cnt
aerogel
electronic
recent progress
maximum adsorption capacity
filter
cycle
conductivity
sensor
direction
opportunity
mg g
adsorption
flexibility
issue
prospect
raman spectroscopy
alignment
interest
detection
high cost
aqueous solution
technology
field
review
good stability
lignin
nanocelluloses
rsm
ionic liquid
perspective
min
research
ppy
need
sugarcane bagasse
gpa
fibrillation
cost
advance
mpa
naoh
afm
width
regard
area
plant
polymer matrix
tempo
biomedicine
plastic
usage
transmission electron microsco
length
hypothesis absence
kpa
trend
emulsion
biocompatibility
comparative study
temperature
packaging
films
biopolymer
sugar
spectroscopy
edx
poly
agnps
biomaterial
3d printing
filler
situ
alginate
scaffold
regenerative medicine
xrd
fourier
diameter
capsule
sem
nanofiller
cell culture
3d bioprinting
cmc
bacterium
cell
bioink
nuclear magnetic resonance
food packaging
tissue
tensile strength
shelf life
dsc
bnc
culture
mouse
proliferation
nanocomposite film
escherichia coli
evaluation
suitability
zno
expression
w v
blood
vitro
wound
antibacterial activity
collagen
water vapor permeability
VOSviewer

a celulose tem participação direta no desenvolvimento da nanotecnologia

o exemplo da tríplice hélice de Grenoble/Fr


London
Bristol
Cardiff
Antwerp
Dortmund
Düsseldo
Brussels
Brighton
Exeter
Cologne
Lille
Plymouth
Belgium
English Channel
Luxembourg
Guernsey
Jersey
Paris
Brest
Strasbourg
Rennes
Vannes
Angers
Tours
Basel
Nantes
Switze
France
La Rochelle
Limoges
Clermont-Ferrand
Lyon
Bay of Biscay
Bordeaux
Toulouse
Montpellier
Monaco
Bilbao
Donostia-San
Sebastian
Aix-en-Provence
Marseille
Pamplona
Vitoria-Gasteiz
Andorra





Pesquisa em Grenoble

- Grenoble é um dos mais dinâmicos ecosistemas de pesquisa da França
- 65.250 estudantes
- 9,000 estudantes internationacionais
- 4 universidades
- 7 escolas de engenharia
- 23 Programas de Mestrado Internacional
- 13 escolas de Doutorado
- 3.600 professores-pesquisadores (full ou associados)
- 90 laboratorios estruturados em 6 departamentos de pesquisa
- 14 laboratórios de excelência - **Labex,** e equipmentos de excelência - **Equipex**
- metade dos 3.700 estudantes de doutorado são internacionais

Nanotechnology and Development: What's in it for Emerging Countries?
edited by Shyama V. Ramani

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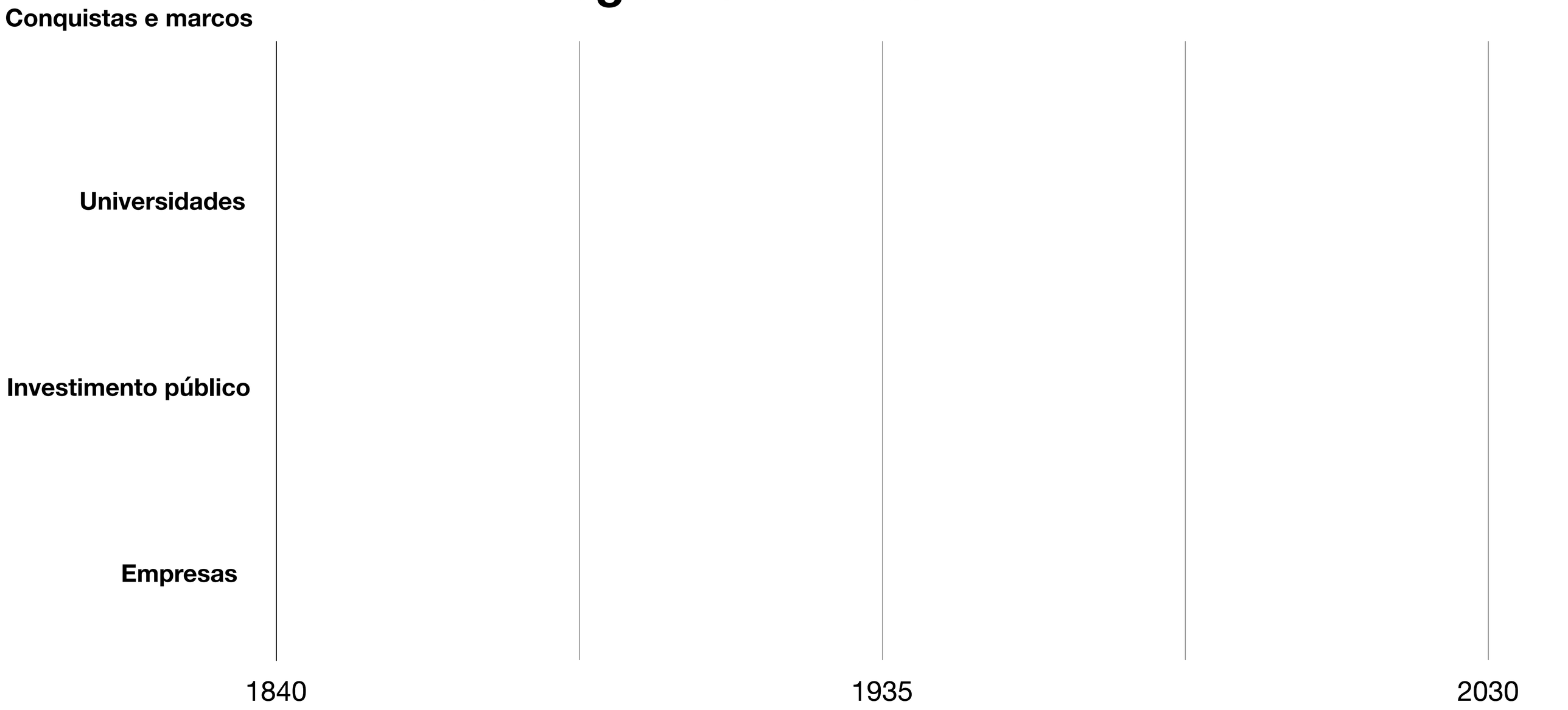

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fábricas de papel
1850

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1840 1935 2030

Fábricas de papel demandam energia

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Hidroelétrica
1869



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Hidroelétrica. Energia para novos empreendimentos

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Fábrica de alumínio
1888



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Produção de alumínio usa eletrólise

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Institute of Electrical Technology
1890

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Agregação dos cursos de engenharia, futuro INP

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papermaking school
1902

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Fundação da École internationale du papier, de la communication imprimée et des biomatériaux - Pagora

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Schneider Electric
1920

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Instalação de fábrica de Eletromecânica

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Viscose
1927



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National Viscose, produção de Viscose até o ano 2000

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Articulação: Polygone Scientifique
1940

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Os trabalhos de Louis Néel e Louis Weil chamam a atenção de empreendedores

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CEA
1956



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Criação do Commissariat à l'énergie atomique et aux énergies alternatives: de la Recherche à l'Industrie

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CERMAV
1966

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Centre de recherches sur les macromolécules végétales

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CEA: LETI
1967

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Laboratoire d'électronique des technologies de l'information

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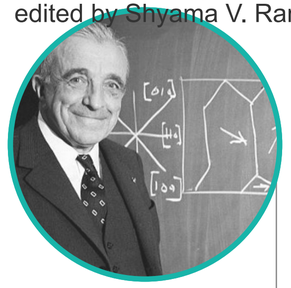

Nobel de Física
1970

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Prêmio Nobel para Louis Neél

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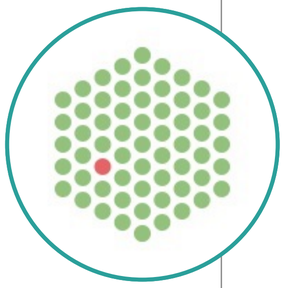

EMBL
1975

1840 1935 2030

EMBL Grenoble. Structural Biology research & services

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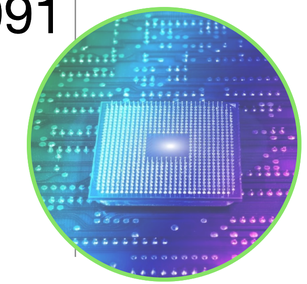
STM
1991



1840

1935

2030

STMmicroeletronics, Semi-condutores, 4mil funcionários

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Synchrotron
1994



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European Synchrotron Radiation Facility

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MINATEC
2006



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Complexo especializado em micro-nano tecnologias

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INTEL Corp
2015



1840 1935 2030

HP + Intel Center of Excellence for High Performance Computing

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Fusion Energy: ITER
2025

1840 1935 2030

Gerador de energia por Fusão, consórcio internacional

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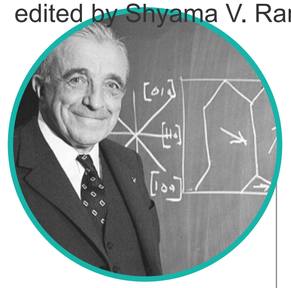

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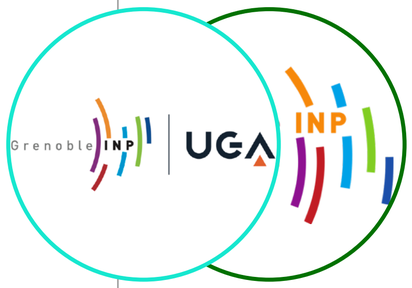



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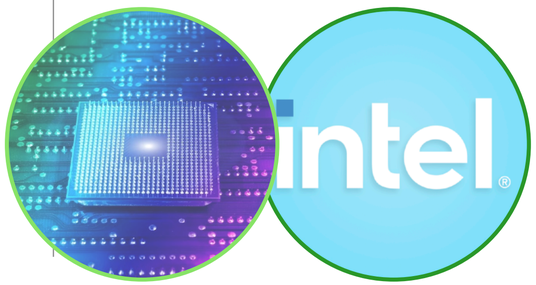
Empresas







1840 1935 2030

Laboratoire d'électronique des technologies de l'information (CEA-Leti)

média de 286 patentes/ano



68 companhias saíram como Spin Offs do CEA-Leti, criando milhares de empregos (2011).

exemplo:
A Soitec Group, desenvolveu tecnologia de substratos semicondutores, que *spun off* do CEA-LETI em 1992.

A Soitec, listada na bolsa reportou em 2020 vendas de €597.5m, 35% de incremento em relação a 2019.

MINATEC®

1,200	3,000	600	20 ha	1,600	350
ESTUDANTES	PESQUISADORES	INDÚSTRIAS	EM INFRAESTRUTURA	PUBLICAÇÕES /ANO	PATENTES /ANO

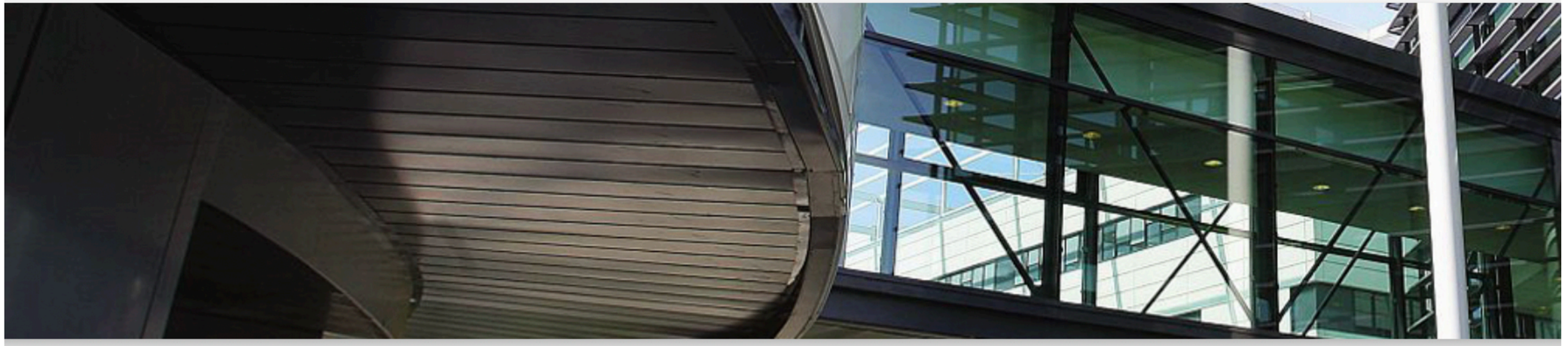







Em 2019, startups do CEA levantaram €101,4 milhões em capital.

Start-ups criaram 2.700 postos de trabalho em áreas de alta tecnologia.



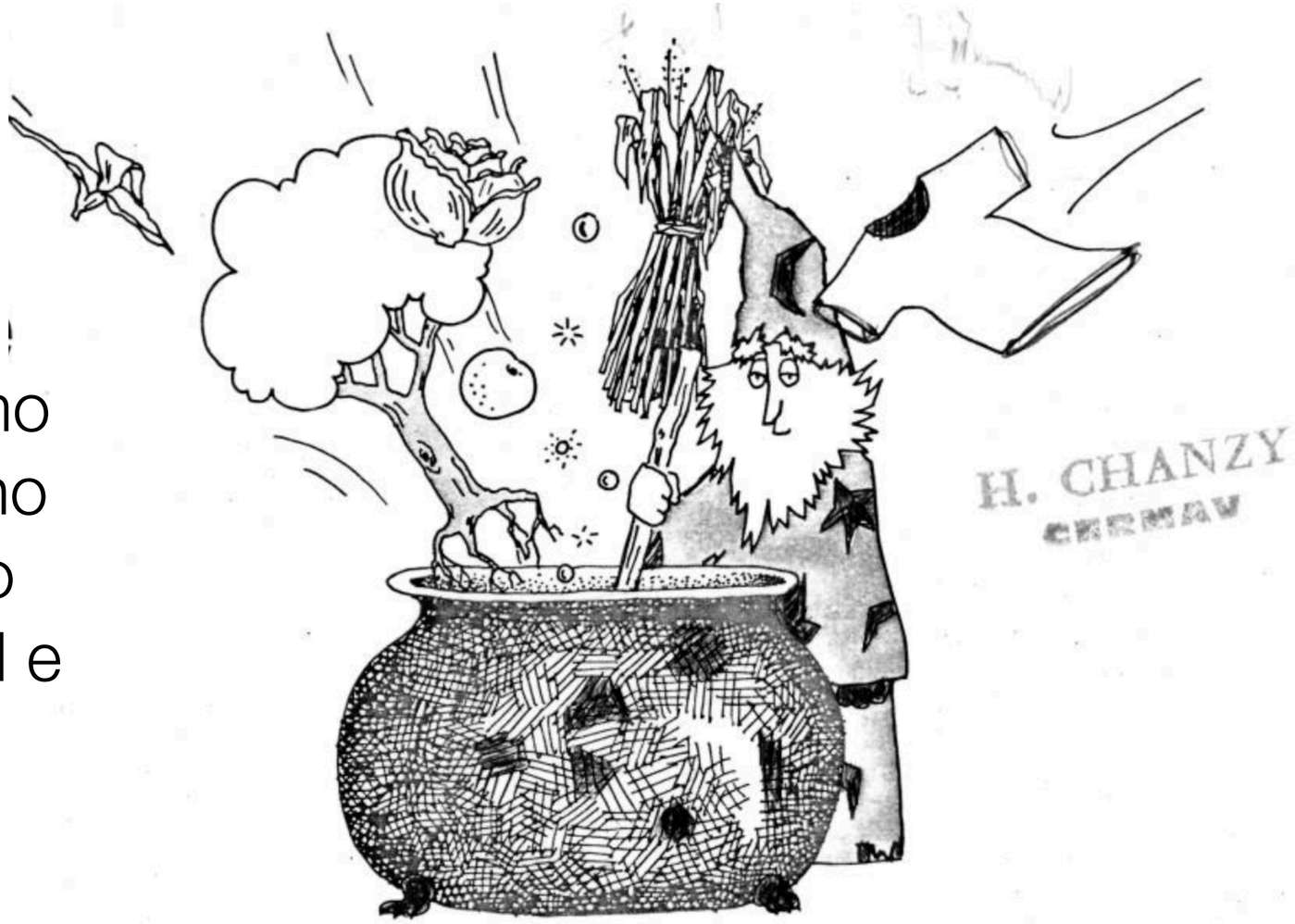
Transparent electrodes based on silver nanowires-nanocellulose: from fundamental aspects to device integration

Published : 8 April 2019

A phD position is offered between LMGP and LGP2 laboratories. The appointment has a fixed duration of 36 months, starting 01/10/2019.

Nanocelulose

A nanocelulose, conhecida como a “fibra pós carbono”, é um nano material capaz de ser produzido em massa, de origem renovável e *biosafe* e *eco-friendly*.

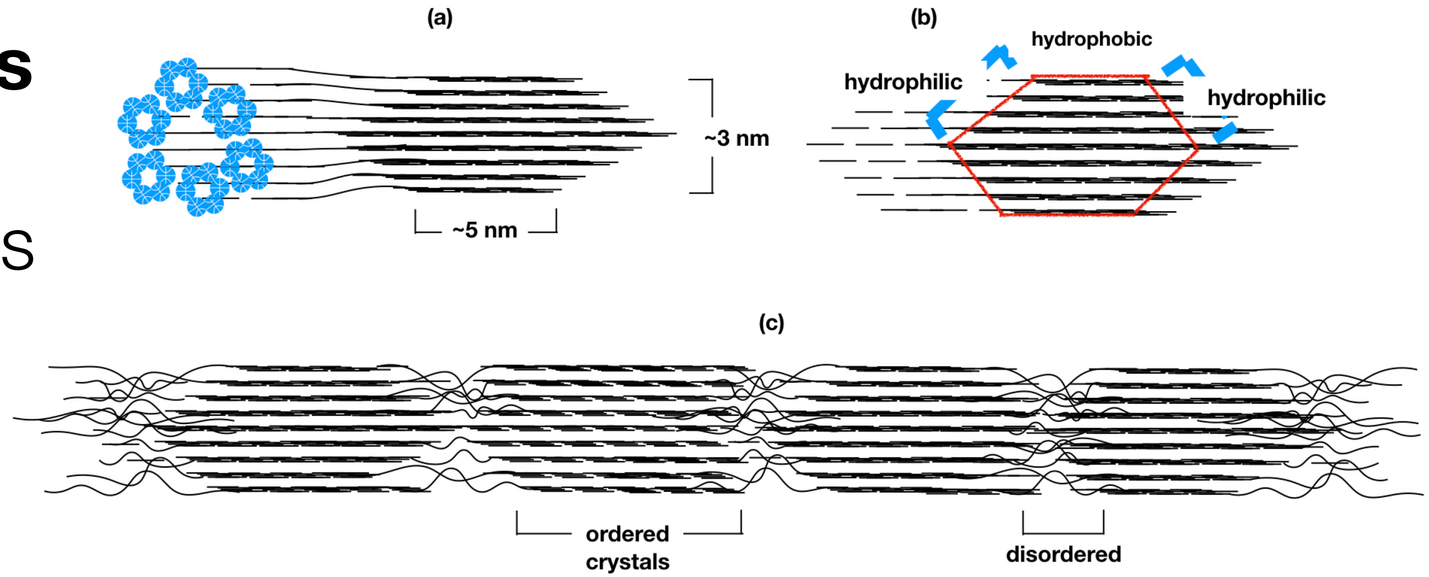


Turbak et all., 1982

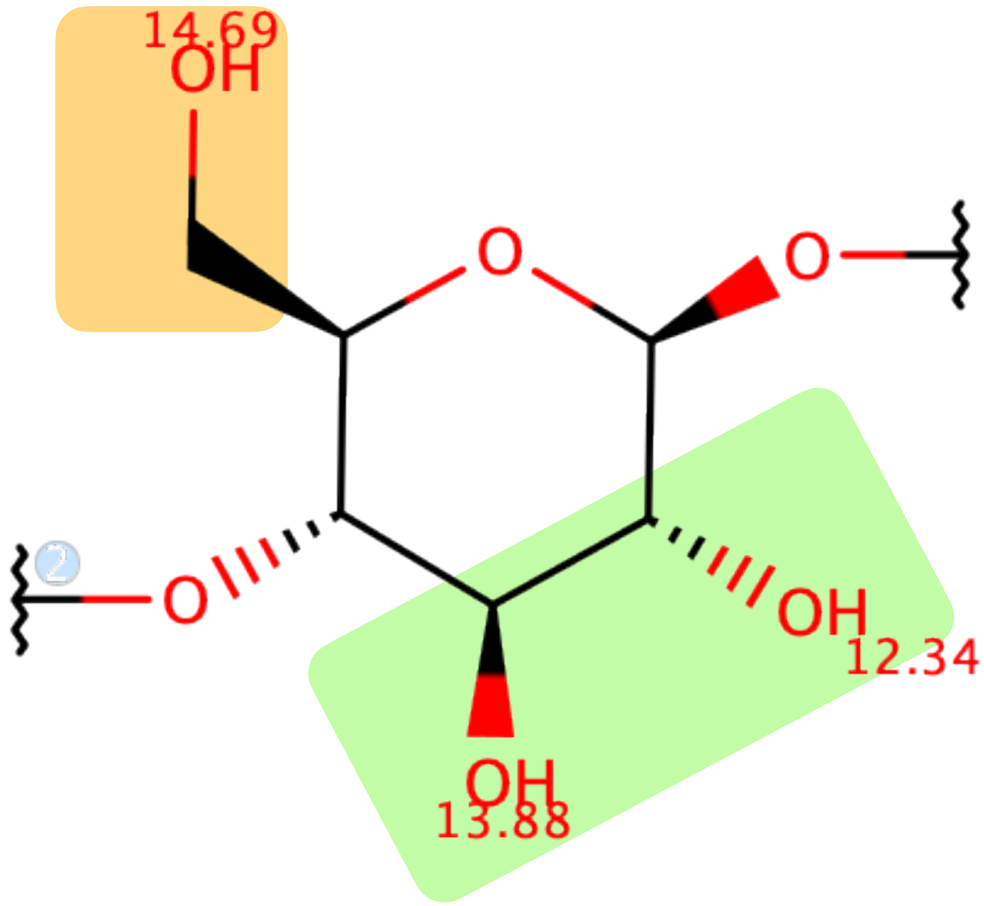
A celulose possui **domínios cristalinos** e **regiões amorfas**

Domínios cristalinos são regiões altamente ordenadas com dimensão de 1 a 100 nm

A proporção de regiões amorfas e cristalinas variam de acordo com a fonte de celulose



biopolímero de baixo custo e versátil



cellulose na UEL

- produção de celulose bacteriana
- produção de nanocelulose:
  - vegetal
  - bacteriana, produção de vinagre
- modificação de celulose e nanocelulose: derivados funcionais
- embalagens biodegradáveis
- nanocelulose como base cosmética

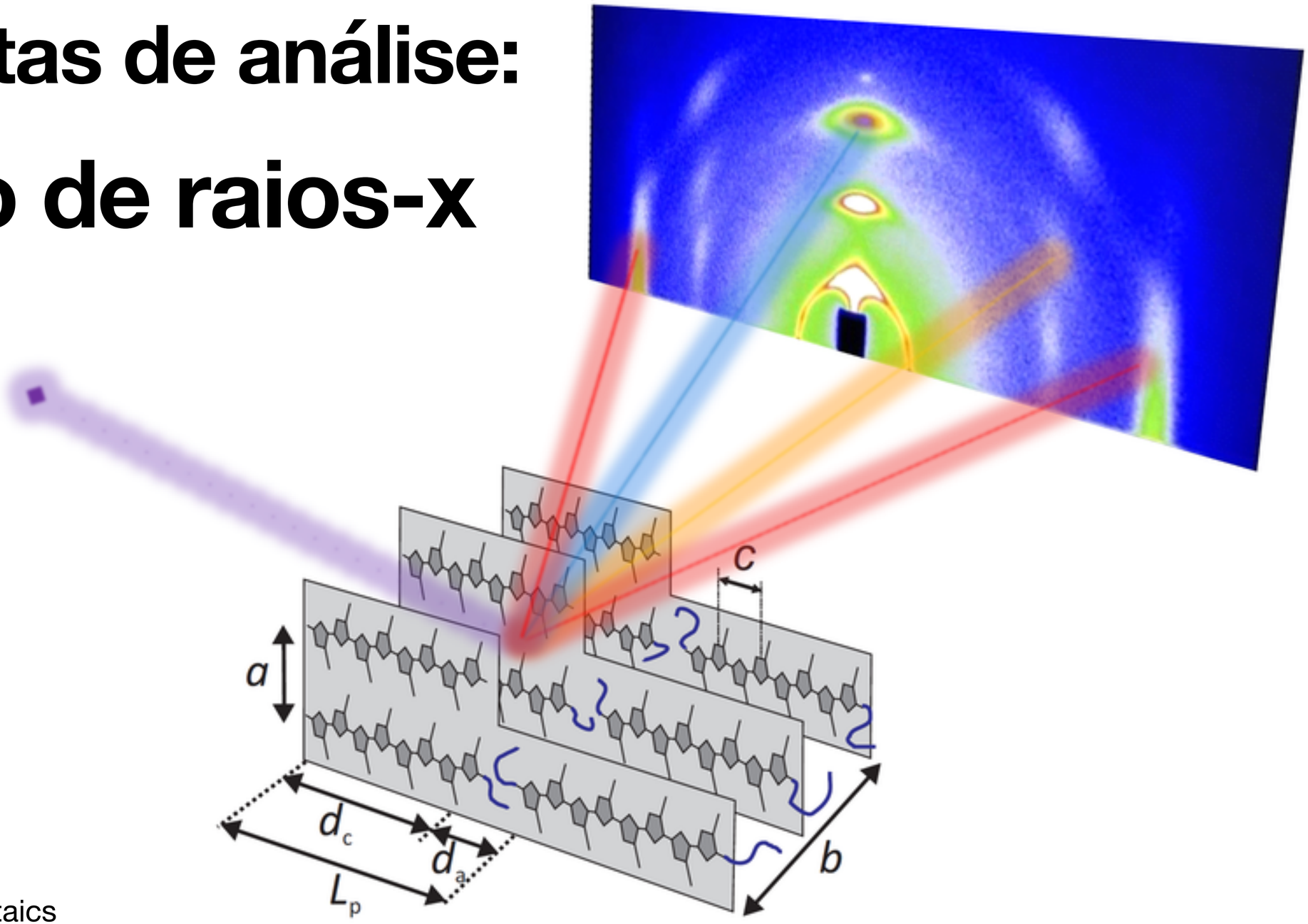
técnicas usadas em nanotecnologia

BBR - Biochemistry and Biotechnology Reports Jan./ Jun., v.1, n.1, p. 32-53, 2012

Morfologia	**Técnicas[1]**
Tamanho (partícula primária)	TEM, SEM, AFM, XRD
Tamanho (primário/agregado/aglomerado)	TEM, SEM, AFM, DLS, FFF, AUC, CHDF, XDC, HPLC, DMA(1), QCM
Distribuição de tamanho	TEM, SEM, AFM, DLS, AUC, FFF, HPLC, SMA
Peso molecular	SLS, AUC, GPC
Estrutura/Formato	TEM, SEM, AFM, NMR
Estabilidade (estrutura 3D)	DLS, AUG, FFF, SEM, TEM, QCM
Superfície	
	BET
Área de superfície	SPM, GE, métodos de titração
Carga de superfície	LDE, ESA, PALS
Potencial Zeta	SPM, XPS, MS, RS, FTIR, NMR,
Composição de revestimento da superfície	
Cobertura de revestimento da superfície	AFM, AUC, TGA
Reatividade da superfície	Varia com o nanomaterial
Interação núcleo-superfície	SPM, RS, ITC, AUC, GE, QCM
Topologia	SEM, SPM, MS
Química	
	XPS, MS, AAS, ICP-MS, RS, FTIR, NMR
Composição química (núcleo, superfície)	
Pureza	ICP-MS, AAS, AUC, HPLC, DSC
Estabilidade (química)	MS, HPLC, RS, FTIR
Solubilidade (química)	Varia com o nanomaterial
Estrutura (química)	NMR, XRD
Cristalinidade	XRD, DSC
Atividade catalítica	Varia com o nanomaterial
Outras	
Incorporação de drogas	MS, HPLC, UV-Vis, Varia com o nanomaterial
Potencial/funcionalidade de drogas	Varia com o nanomaterial
Liberação in vitro (detecção)	UV-Vis, MS, HPLC. Varia com o nanomaterial
Deformabilidade	AFM, DMA(2)

ferramentas de análise:

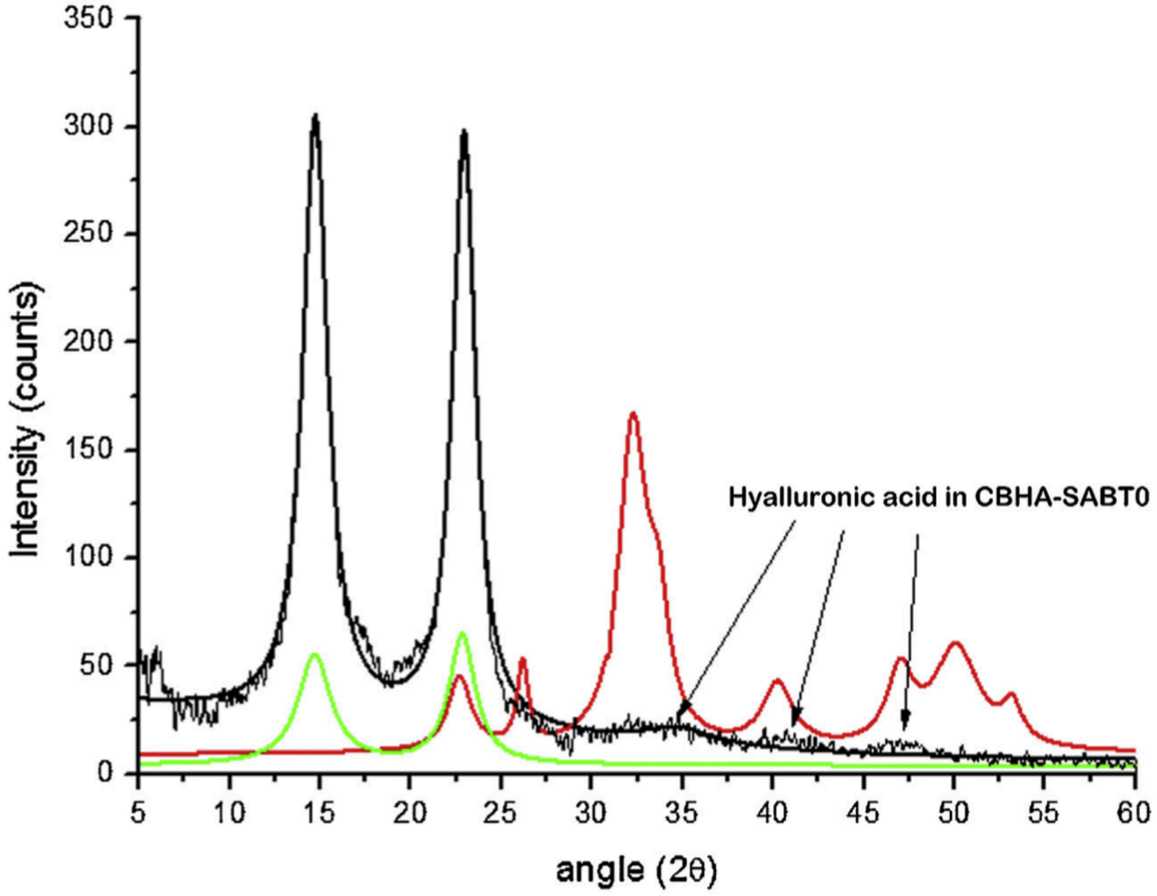
Difração de raios-x



http://www.am-institute.ch/research/projects/structure-formation-in-organic-photovoltaics

ferramentas de análise:

Difração de raios-x



Contents lists available at ScienceDirect

International Journal of Biological Macromolecules

journal homepage: www.elsevier.com/locate/ijbiomac

Production and characterization of bacterial cellulose membranes with hyaluronic acid from chicken comb

Sabrina Alves de Oliveira[a], Bruno Campos da Silva[b], Izabel Cristina Riegel-Vidotti[b], Alexandre Urbano[c], Paula Cristina de Sousa Faria-Tischer[a], Cesar Augusto Tischer[a,*]

[a] Departament of Biochemistry and Biotechnology, Londrina State University—UEL, CEP 86051-980, Londrina, PR, Brazil
[b] Departament of Chemistry, Federal University of Parana—UFPR, CEP 81531-980, Curitiba, PR, Brazil
[c] Departamento of Physics, Londrina State University—UEL, CEP 86051-980, Londrina, PR, Brazil

ferramentas de análise:

Microscopia de Força Atômica

Celulose Bacteriana nativa

Celulose Bacteriana Succinilada

Celulose Bacteriana Manosilada

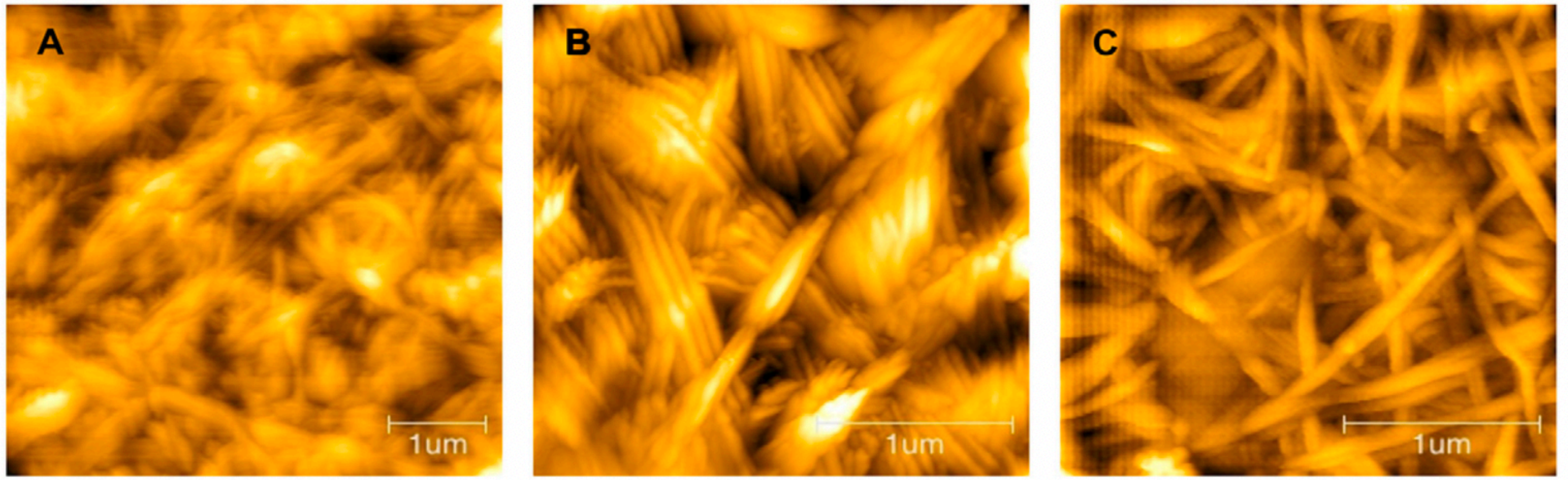


Fig. 5. AFM images of native bacterial cellulose (A), succinylated cellulose (B) and mannosylated bacterial cellulose (C).

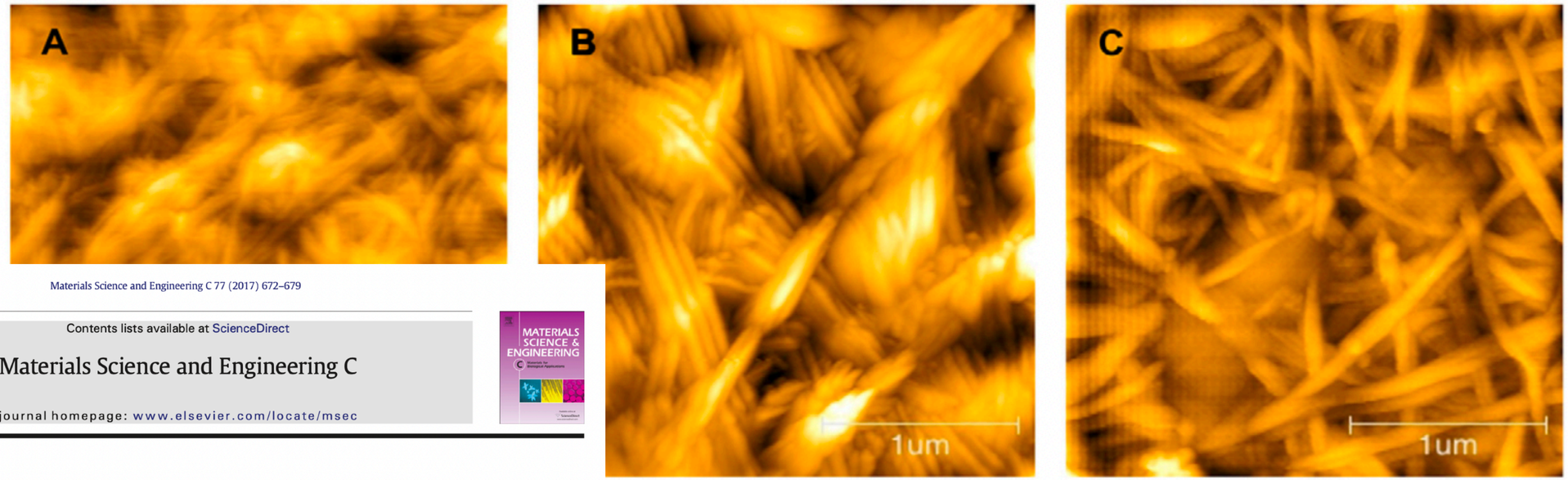
ferramentas de análise:

Microscopia de Força Atômica

Celulose Bacteriana nativa

Celulose Bacteriana Succinilada

Celulose Bacteriana Manosilada



Materials Science and Engineering C 77 (2017) 672–679

Contents lists available at ScienceDirect

Materials Science and Engineering C

journal homepage: www.elsevier.com/locate/msec

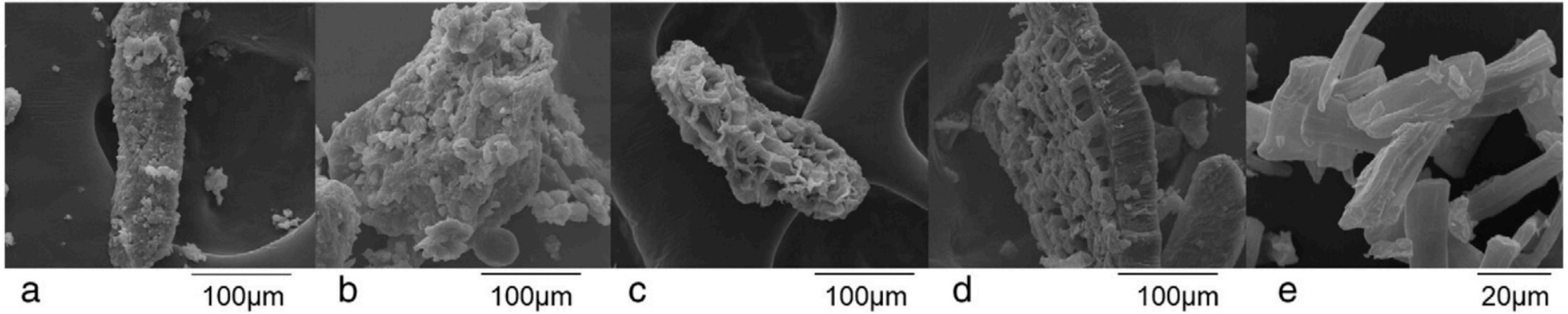
Enhancement of fibroblast growing on the mannosylated surface of cellulose membranes

Simone Birkheur [a], Paula Cristina de Sousa Faria-Tischer [b], Cesar A. Tischer [b], Elisângela Flávia Pimentel [c], Marcio Fronza [c], Denise Coutinho Endringer [c], Anna Paola Butera [a], Renato Márcio Ribeiro-Viana [d,*]

ılose (A), succinylated cellulose (B) and mannosylated bacterial cellulose (C).

ferramentas de análise:

Microscopia Eletrônica de Varredura



Contents lists available at ScienceDirect

Food Research International

journal homepage: www.elsevier.com/locate/foodres

Properties of microcrystalline cellulose extracted from soybean hulls by reactive extrusion

Aline Merci [a], Alexandre Urbano [b], Maria Victória E. Grossmann [c], Cesar A. Tischer [a], Suzana Mali [a,*]

INPI INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL

13/04/2018 870180029934 14:40

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Pedido nacional de Invenção, Modelo de Utilidade, Certificado de Adição de Invenção e entrada na fase nacional do PCT

Número do Processo: BR 10 2018 007510 1

Dados do Depositante (71)

Depositante 1 de 1

Nome ou Razão Social: UNIVERSIDADE ESTADUAL DE LONDRINA

Tipo de Pessoa: Pessoa Jurídica

Dados do Pedido

Natureza Patente: 10 - Patente de Invenção (PI)

Título da Invenção ou Modelo de Utilidade (54): PROCESSO DE OBTENÇÃO DE CELULOSE NANOFIBRILADA A PARTIR DE RESÍDUO LIGNOCELULÓSICO EMPREGANDO EXTRUSÃO REATIVA

Resumo: A presente invenção refere-se ao processo de produção de celulose nanofibrilada a partir de resíduos lignocelulósicos empregando a combinação de branqueamento com ácido peracético seguido do





INPI INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL

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Pedido nacional de Invenção, Modelo de Utilidade, Certificado de Adição de Invenção e entrada na fase nacional do PCT

Número do Processo: BR 10 2020 004303 0

Dados do Depositante (71)

Depositante 1 de 1

Nome ou Razão Social: UNIVERSIDADE ESTADUAL DE LONDRINA

Tipo de Pessoa: Pessoa Jurídica

Dados do Pedido

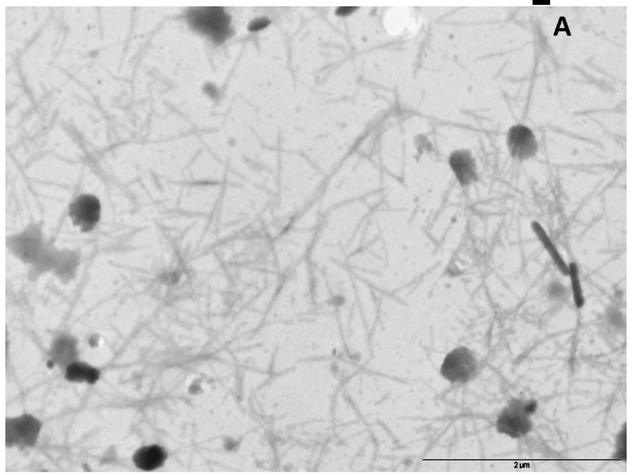
Natureza Patente: 10 - Patente de Invenção (PI)

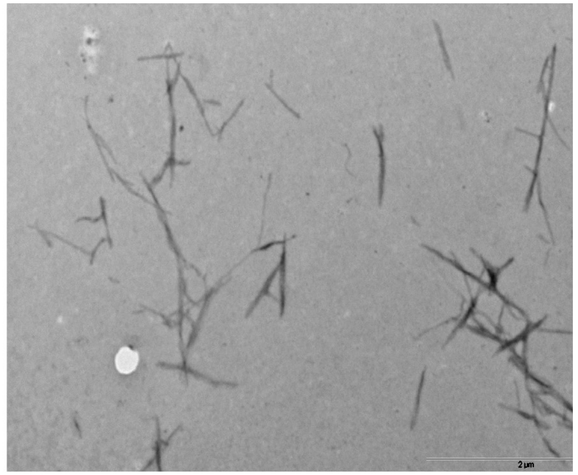
Título da Invenção ou Modelo de Utilidade (54): PROCESSO DE HIDROFOBIZAÇÃO DE CELULOSE EXTRAIDA DE RESÍDUOS DA AGROINDÚSTRIA

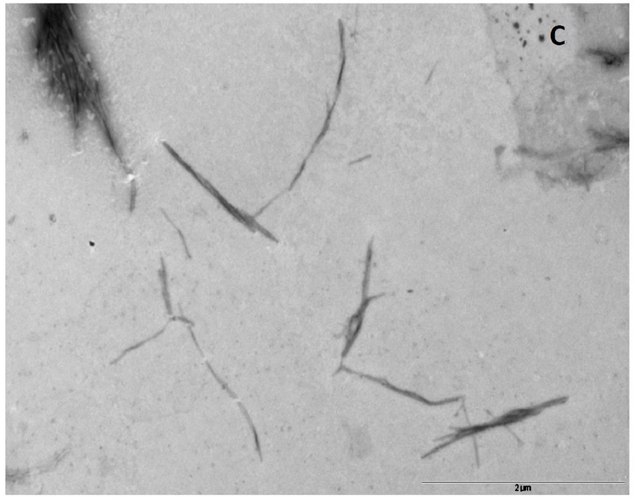
Resumo: A presente invenção descreve o processo de produção da celulose hidrofóbica a partir de resíduos da agroindústria, empregando-se como agentes de esterificação óleos vegetais de baixo custo, como por exemplo, os óleos de soja, girassol e coco, realizada através de

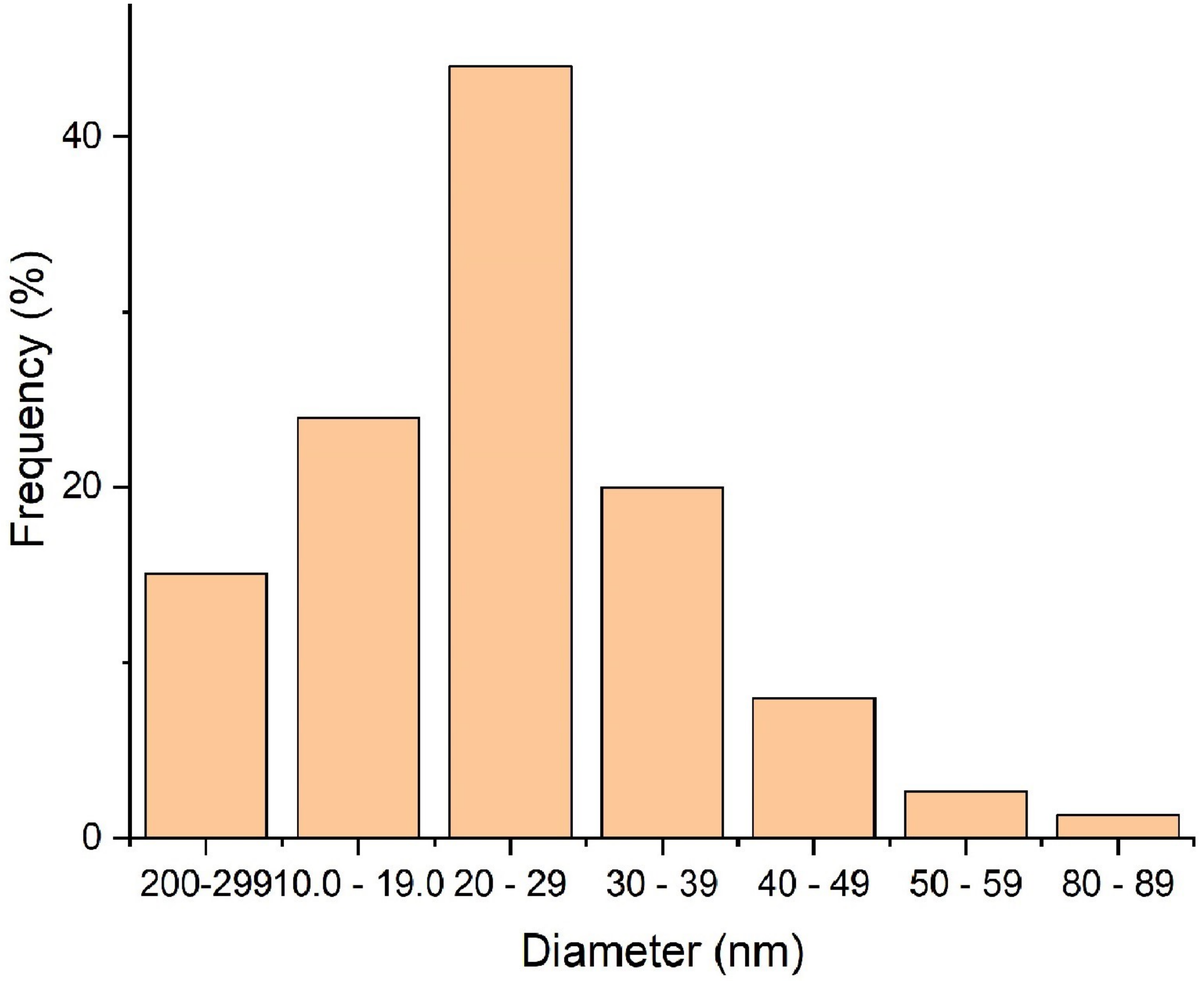
ferramentas de análise:

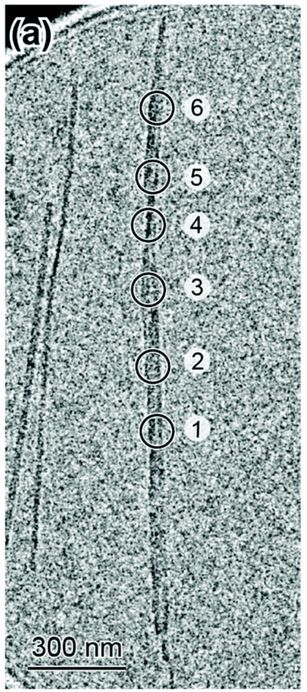
Microscopia Eletrônica de Transmissão

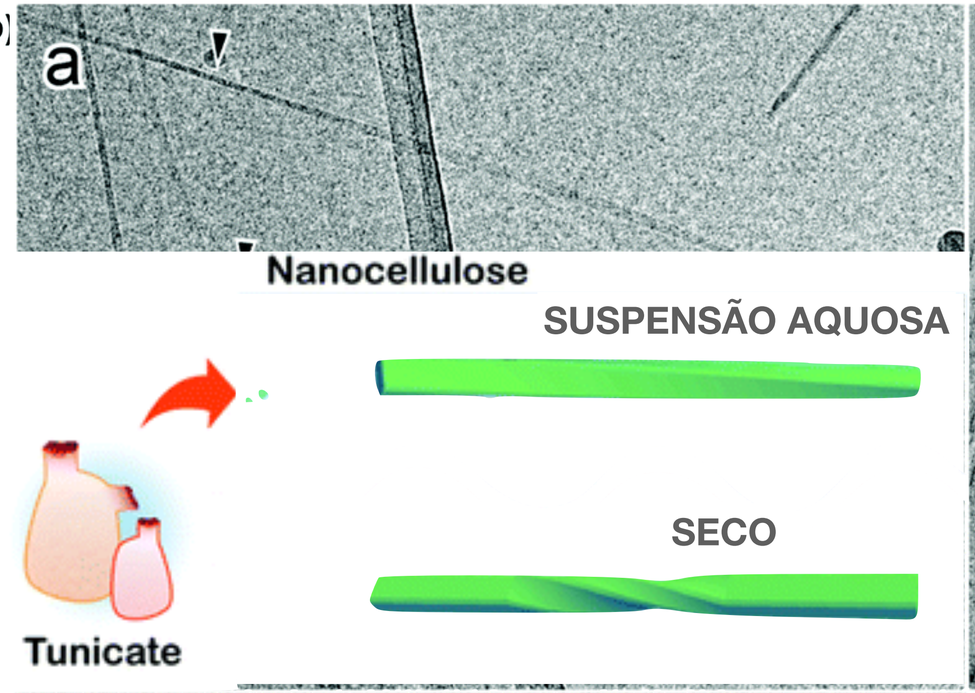


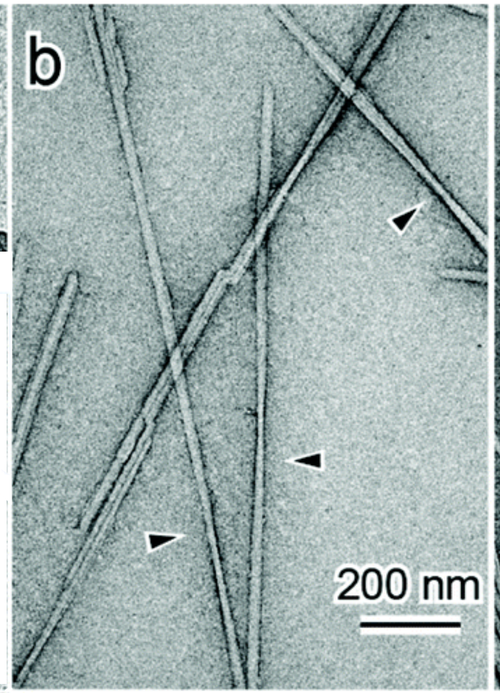


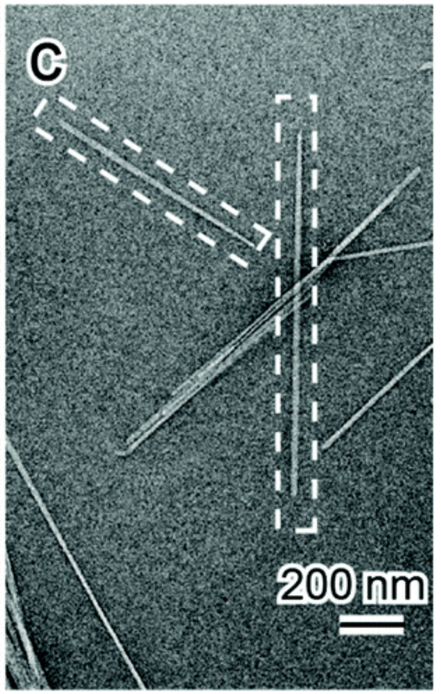


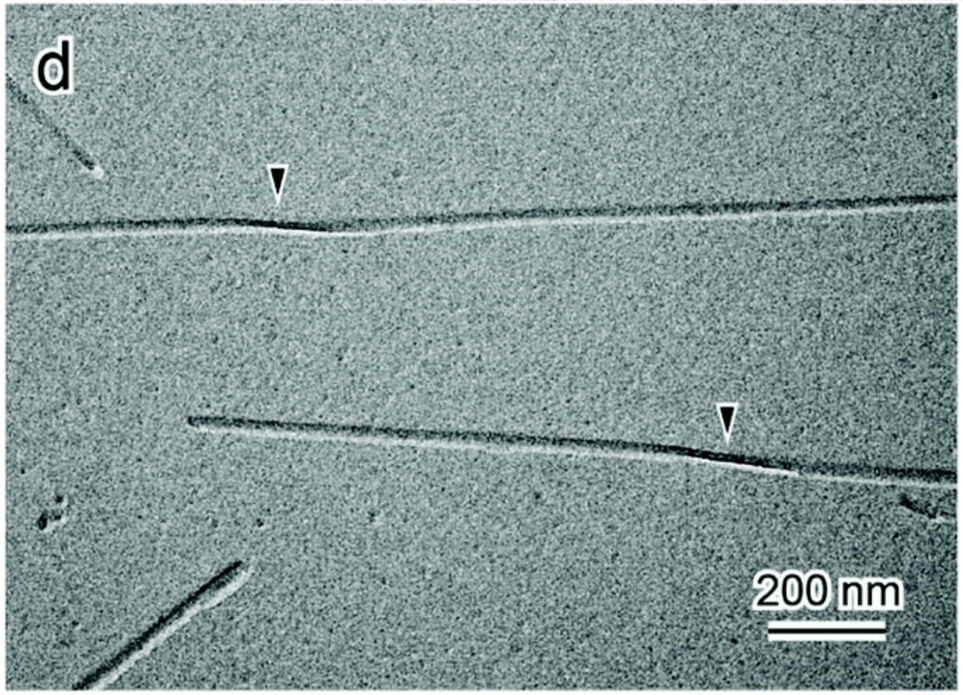


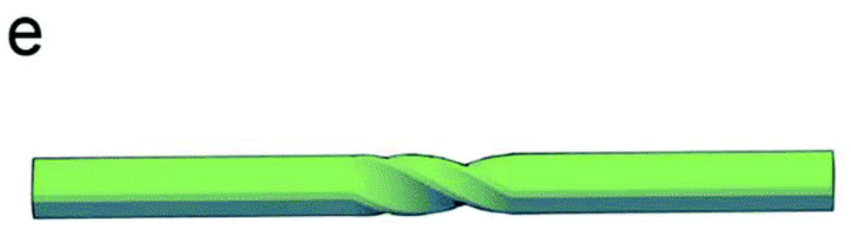


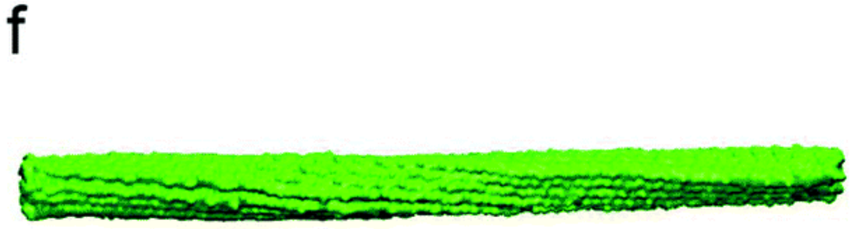








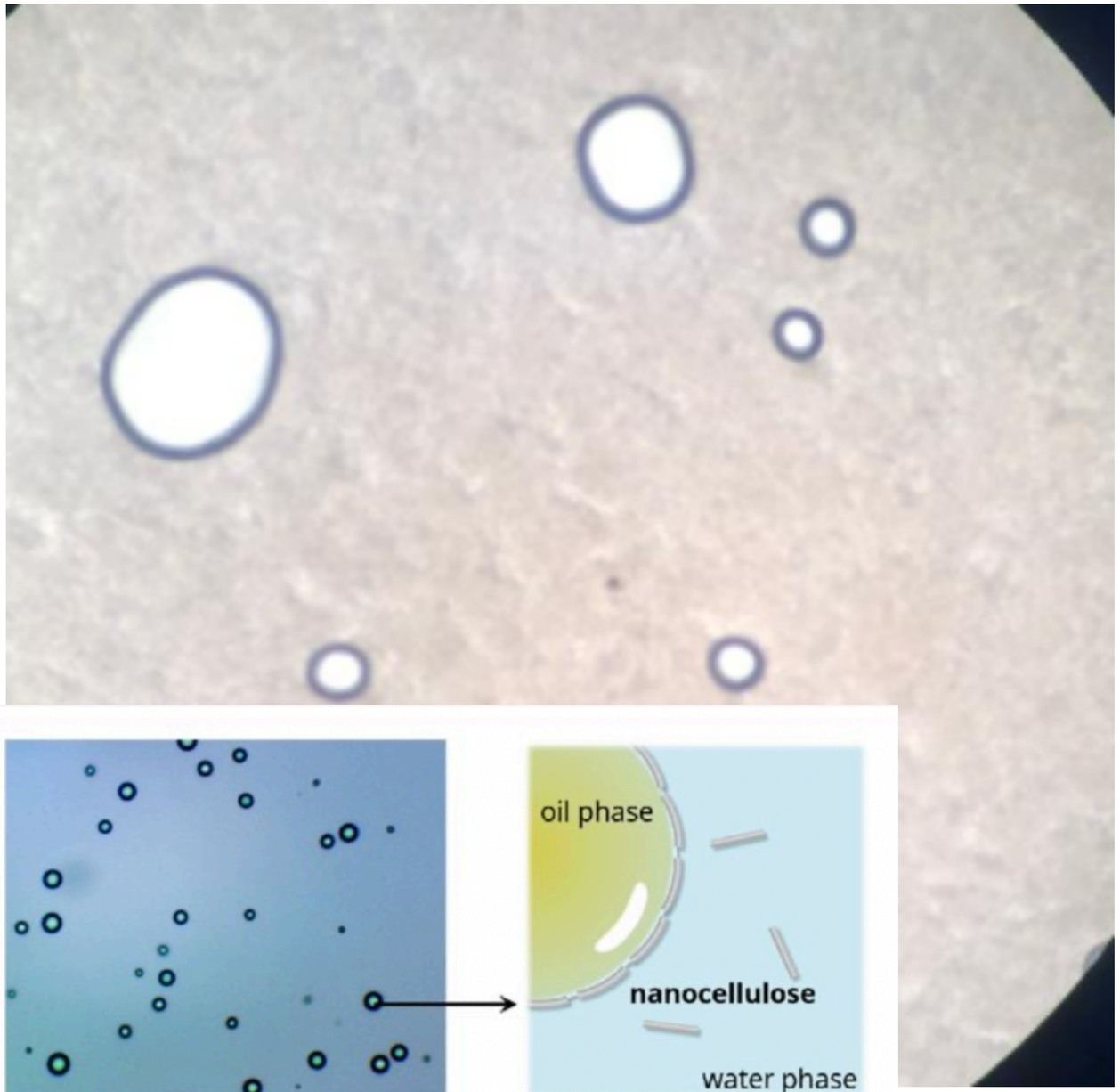


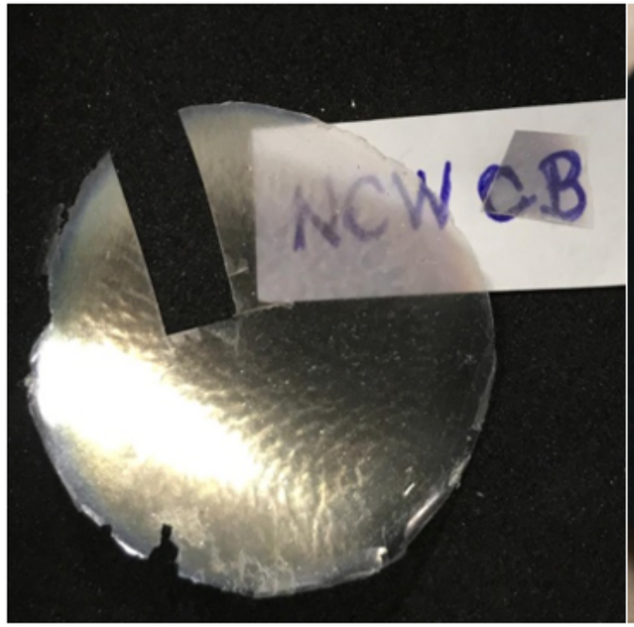


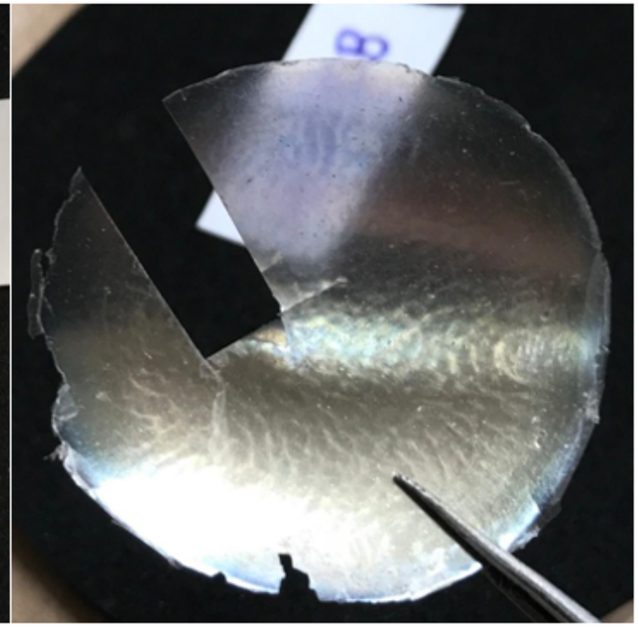
Ogawa, Y. (2019). Electron microdiffraction reveals the nanoscale twist geometry of cellulose nanocrystals. *Nanoscale*,

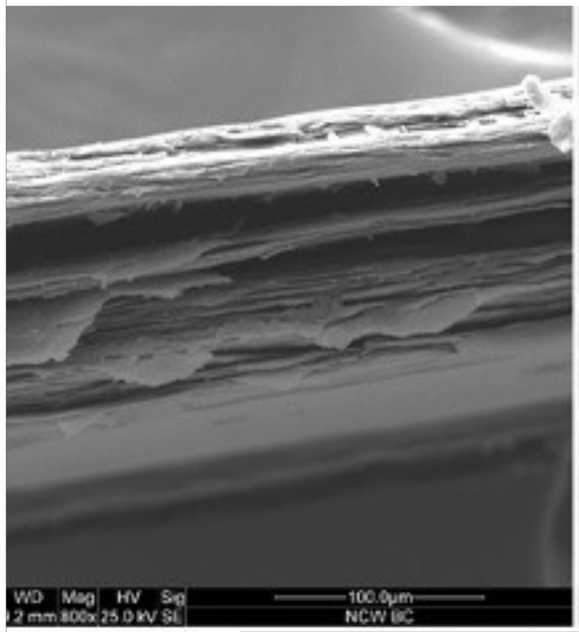
Desenvolvimento de formulação para uso veterinário: acordo com a empresa Vencofarma/Dechra

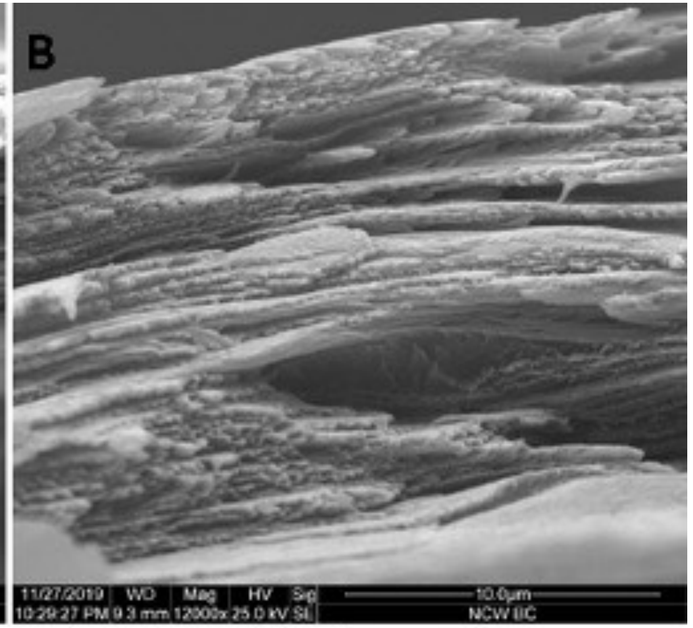












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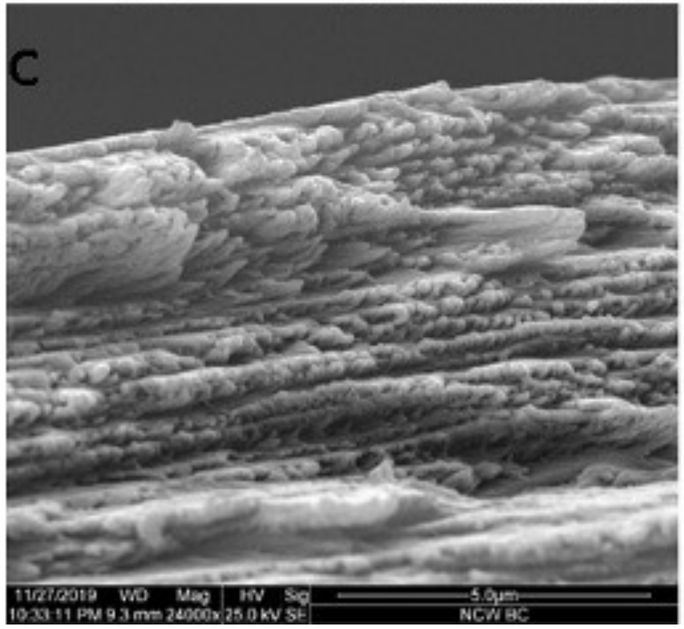
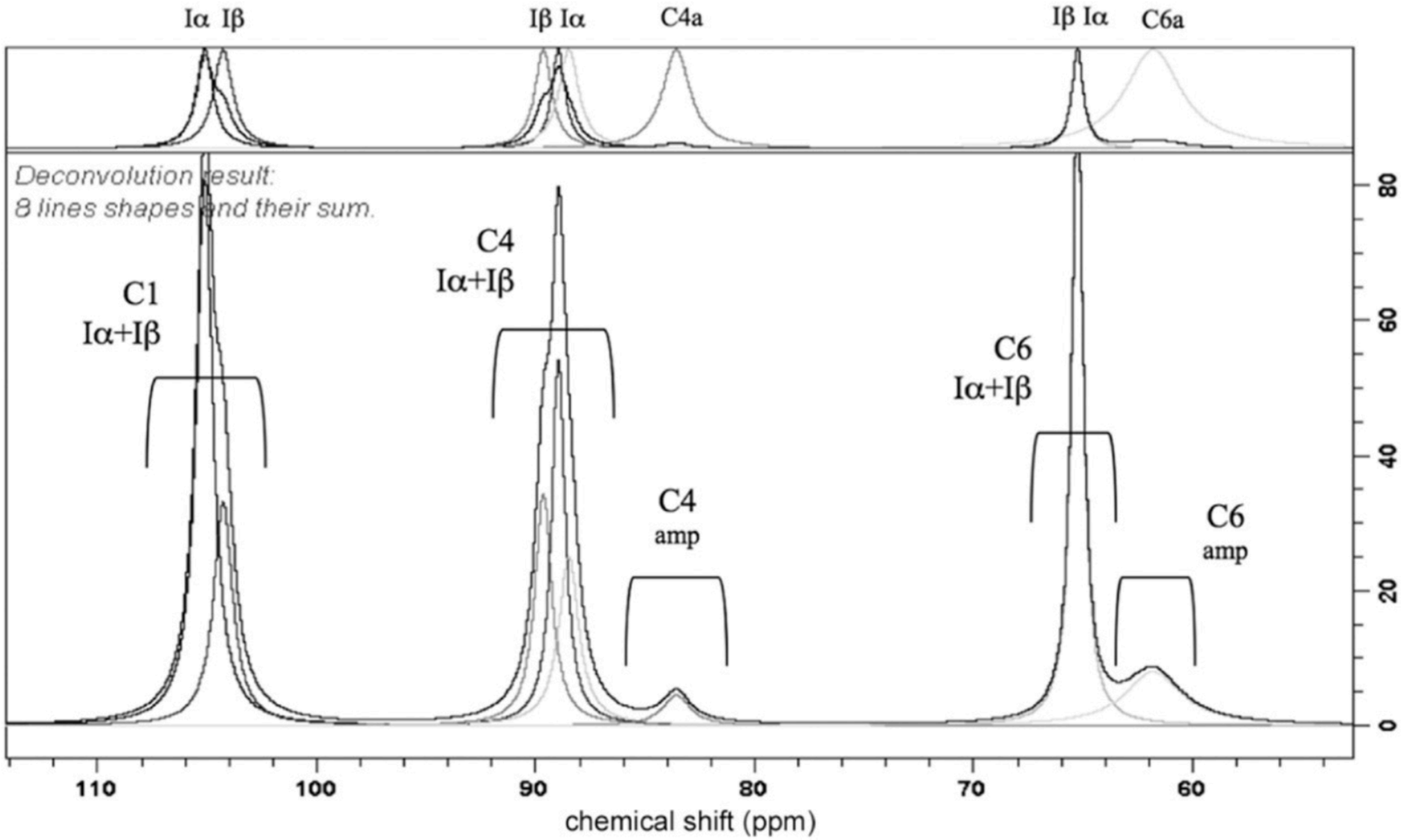
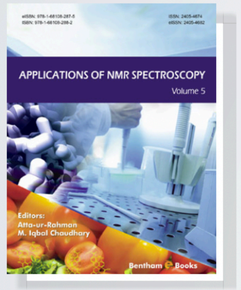


ferramentas de análise - rmn de sólidos



Materials Science and Engineering C 51 (2015) 167–173



Applications of NMR Spectroscopy

Volume: 5

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eISBN: 978-1-68108-287-5, 2016
ISBN: 978-1-68108-288-2
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ISSN: 2405-4682 **(Online)**

Other

Indexed in: Scopus, EBSCO.

Applications of NMR Spectroscopy is a book series devoted to publishing the latest advances in the applications of nuclear magnetic resonance (NMR) spectroscopy in various fields of organic ...

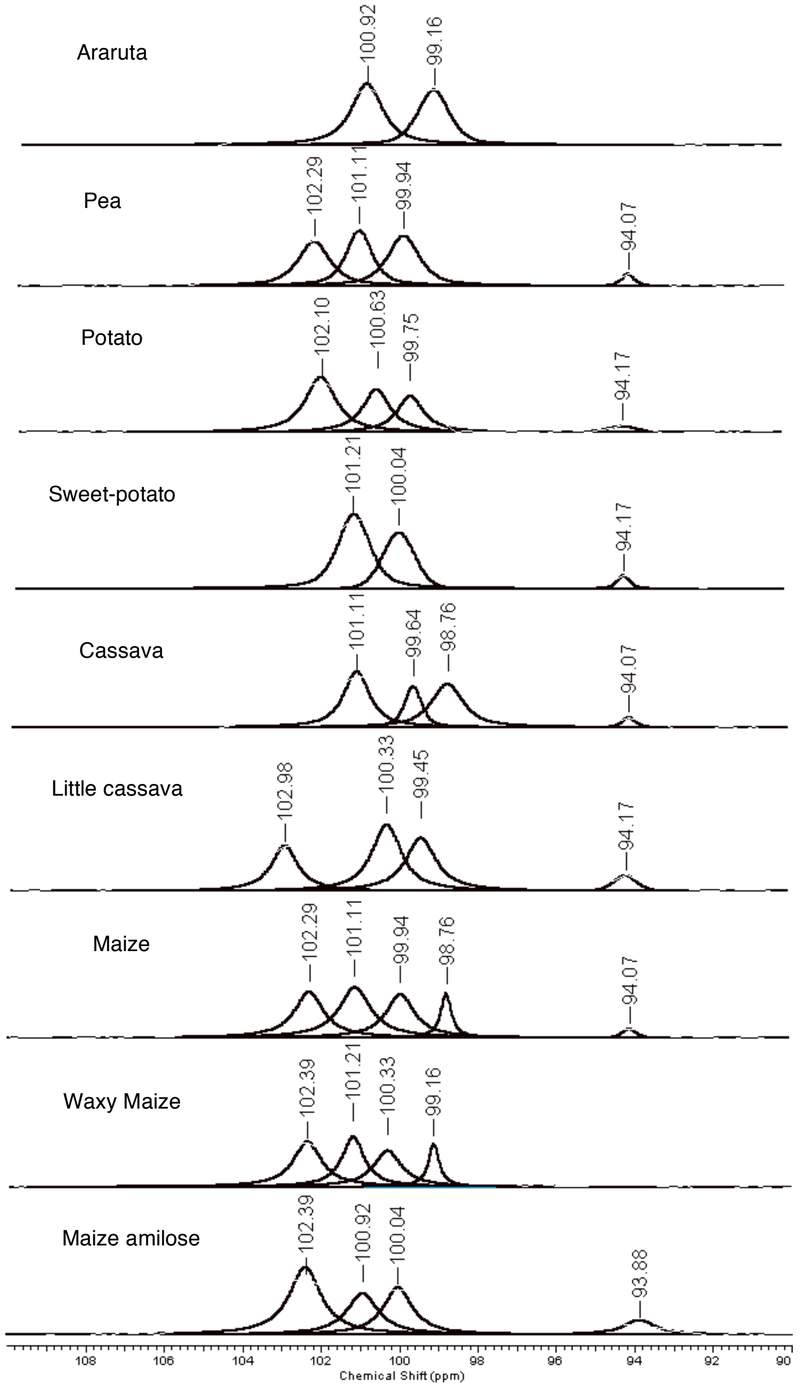
Solid State NMR of Food and Biopolymers

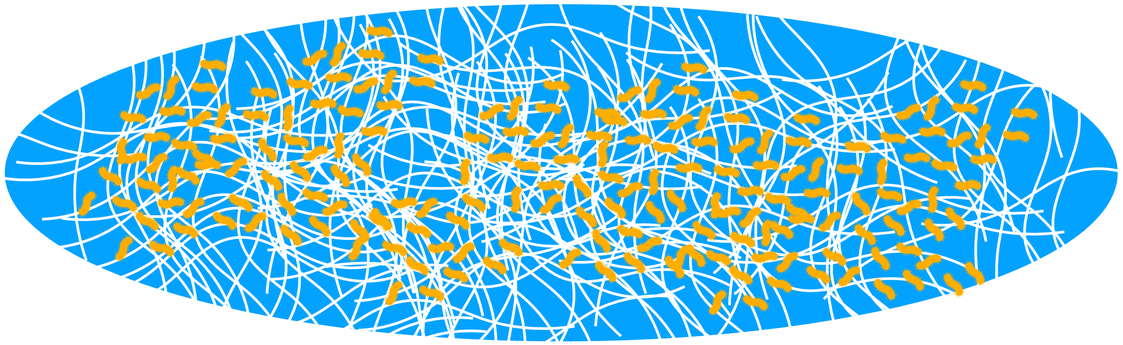
Pp. 244-265 (22)

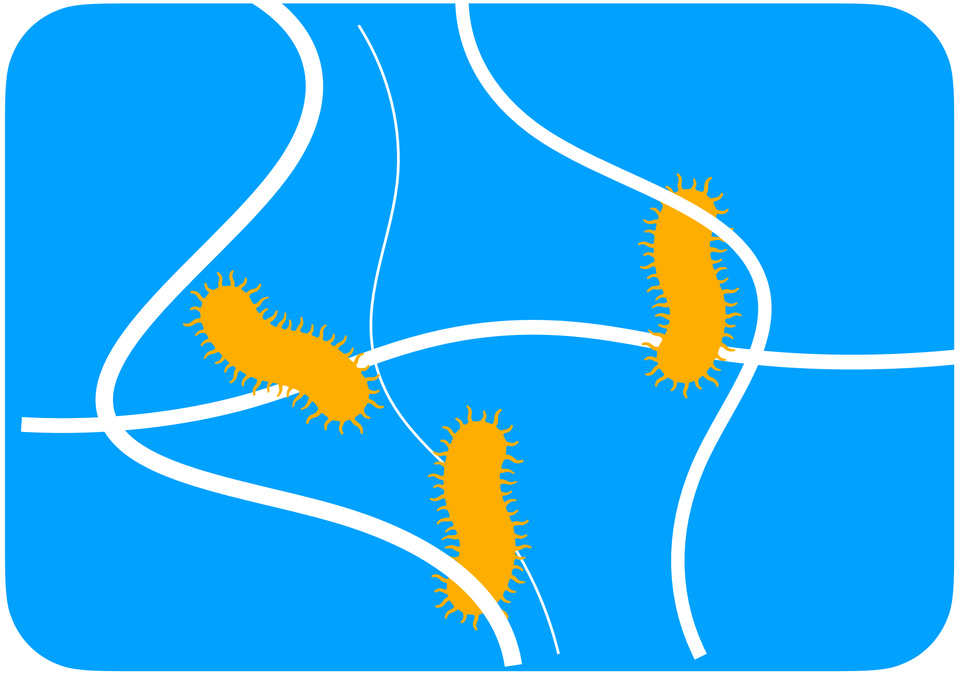
Cesar Augusto Tischer and Suzana Mali

Abstract

Nuclear magnetic resonance (NMR) is widely applied in chemistry and biochemistry, as well as in materials scien structures by a fingerprint are common uses of liquid state NMR. Solid state NMR provides another added adva multistep sample preparation and in a non-destructive way; these aspects greatly speed up sample analysis. Re the development of hardware for solid state NMR and a more versatile technique, cross polarization - magical ar operationally less expensive and reliable even when performed by non-highly trained experts. These developme Here, we present some technical considerations for the implementation of solid state NMR as a reproducible tec pulses and spectral calibrations. The potential target compounds in food analysis are discussed regarding the ty content and quality lead to different spectra as well as physical-chemical characteristics with an impact on the o crystal arrangement and uses of the starch flour were reviewed to explain the role of materials science tools and o- -the-art starch analysis and to assess its role in flour products; solid state NMR spectroscopy has considerab validate processes and products. Finally, we suggest parameters for future standardized experiments and the pc







2017 registro UEL INPI BR 10201700663

PRODUÇÃO DE RAMNOLIPÍDEOS POR FERMENTAÇÃO ESTÁTICA EM SUPORTE DE MEMBRANAS DE CELULOSE BACTERIANA

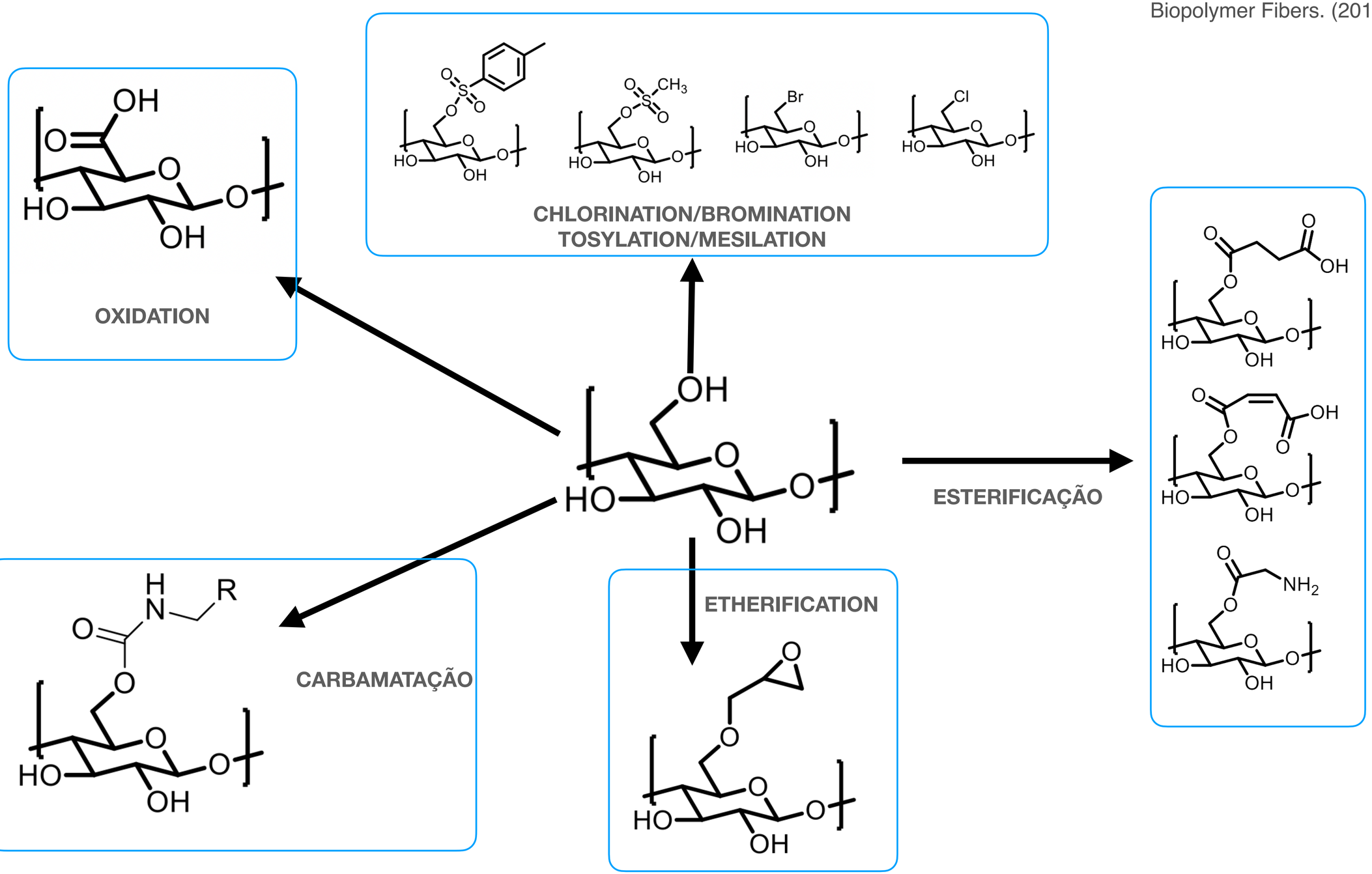
Environmental Science and Pollution Research
https://doi.org/10.1007/s11356-020-09315-w

RESEARCH ARTICLE

Rhamnolipid production by *Pseudomonas aeruginosa* grown on membranes of bacterial cellulose supplemented with corn bran water extract

Karen Stefany Conceição [1] · Mayara de Alencar Almeida [1,2] · Isadora Caroline Sawoniuk [1] · Gabriela Dornelas Marques [1] · Paula Cristina de Sousa Faria-Tischer [1] · Cesar Augusto Tischer [1] · Josiane Alessandra Vignoli [1] · Doumit Camilios-Neto [1]

Materials for Biomedical Engineering
Biopolymer Fibers. (2019):205-244



INPI INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL

08/10/2020 870200127250 15:53

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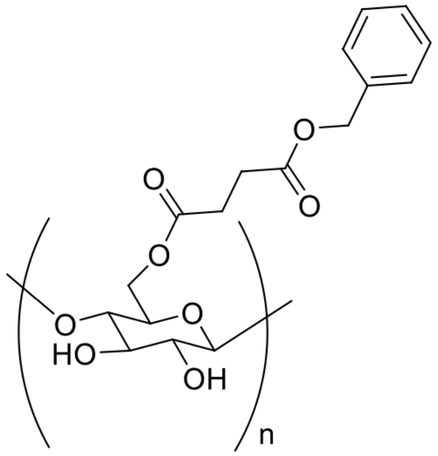
Pedido nacional de Invenção, Modelo de Utilidade, Certificado de Adição de Invenção e entrada na fase nacional do PCT

Número do Processo: BR 10 2020 020709 1

Dados do Depositante (71)

Depositante 1 de 2

Nome ou Razão Social: UNIVERSIDADE TECNOLOGICA FEDERAL DO PARANA



8. FILME DE CELULOSE BACTERIANA HIDROFOBIZADO COM MAIOR COMPATIBILIDADE COM FIBROBLASTOS E ATIVIDADE ANTIMICROBIANA,

Dados do Pedido

Natureza Patente: 10 - Patente de Invenção (PI)

Título da Invenção ou Modelo de Utilidade (54): PROCESSO DE PREPARAÇÃO DE FILMES DE CELULOSE BACTERIANA HIDROFOBIZADOS COM MAIOR COMPATIBILIDADE COM FIBROBLASTOS, ATIVIDADE ANTIMICROBIANA E SUA APLICAÇÃO COMO CURATIVO

Resumo: A presente invenção descreve a preparação de um filme a base de celulose bacteriana que possui sua superfície hidrofobizada. Este é preparado pela modificação química de sua superfície com



INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL

28/05/2021 870210048705 16:51

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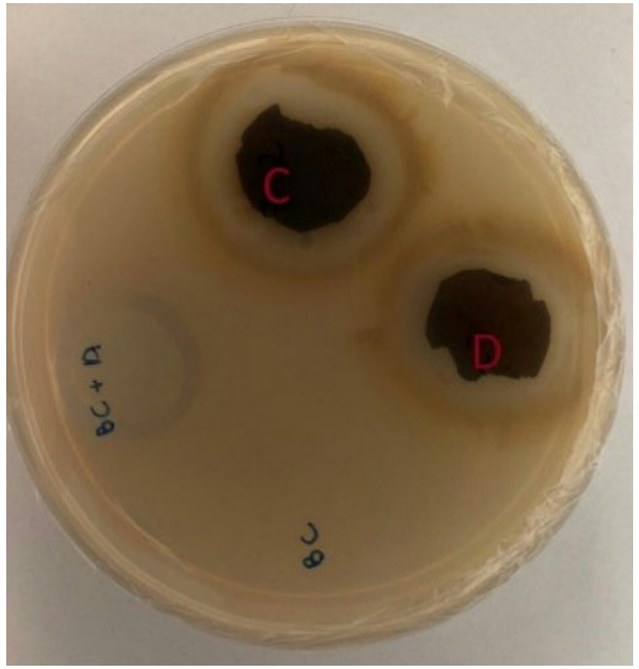
Pedido nacional de Invenção, Modelo de Utilidade, Certificado de Adição de Invenção e entrada na fase nacional do PCT

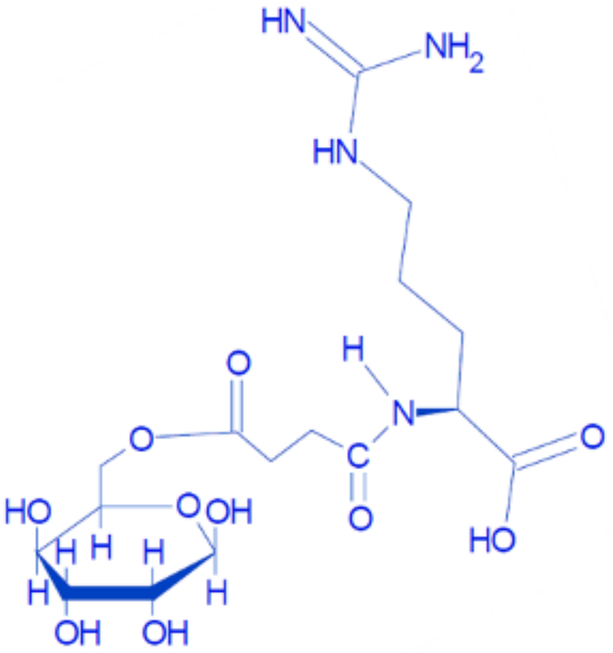
Número do Processo: BR 10 2021 010458 9

Dados do Depositante (71)

Depositante 1 de 1

Nome ou Razão Social: UNIVERSIDADE ESTADUAL DE LONDRINA



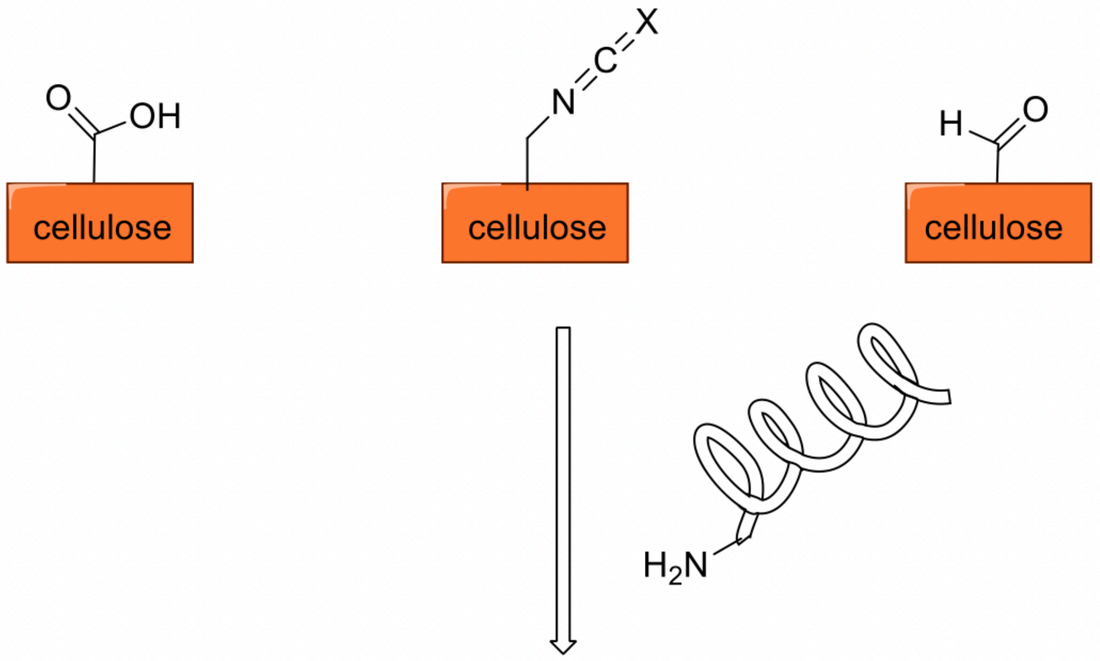


Dados do Pedido

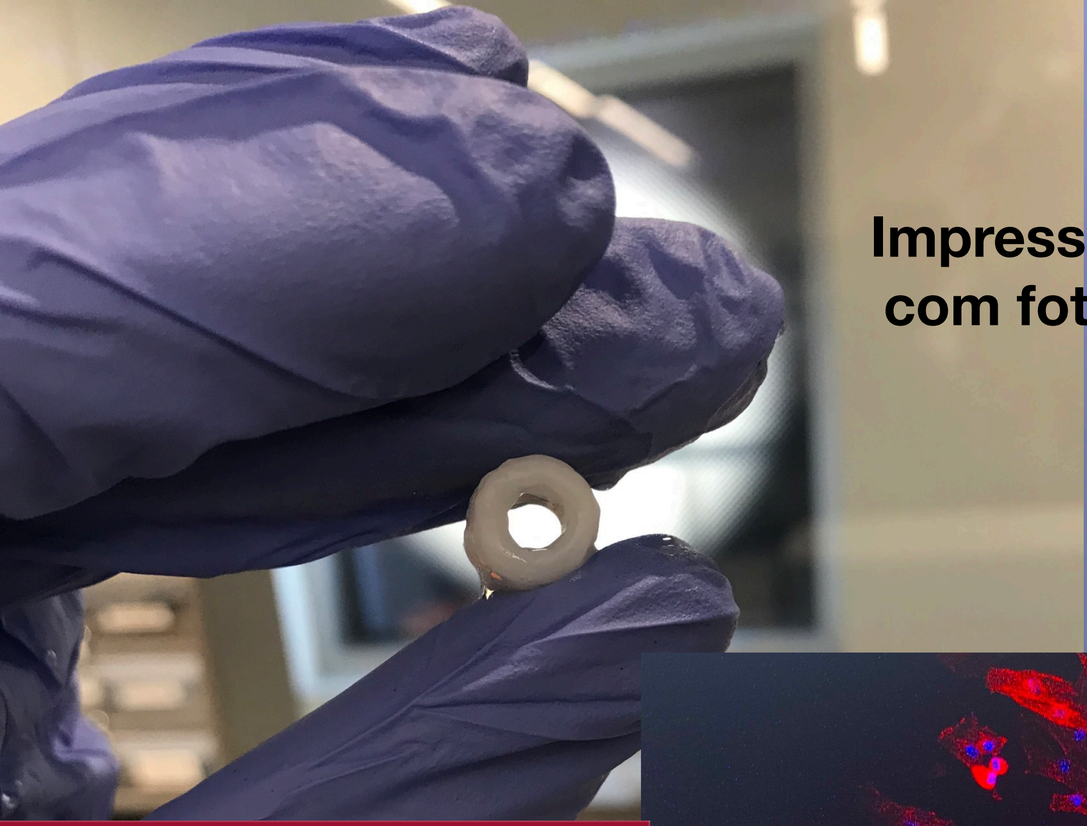
Natureza Patente: 10 - Patente de Invenção (PI)

Título da Invenção ou Modelo de Utilidade (54): Nanocelulose funcionalizada com arginina e nanopartículas de prata com atividade antibacteriana

Resumo: A presente invenção é um material de nanopartículas de celulose funcionalizadas com arginina ligada à nanopartículas de prata. A nanocelulose pode ser obtida de celulose produzida pela bactéria Komagataeibacter xylinus tratada por hidrólise ácida, ou de



Típica reação de acoplamento de grupos amino de proteínas em derivados de celulose



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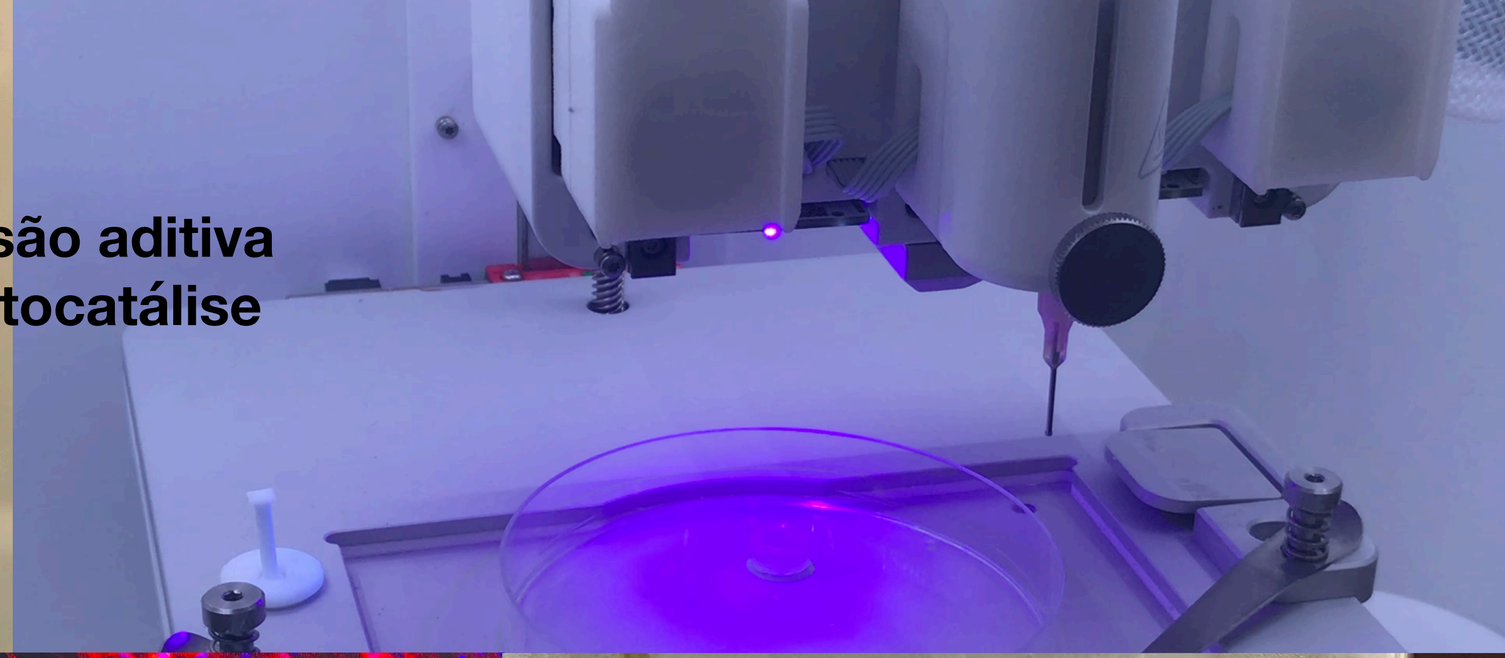

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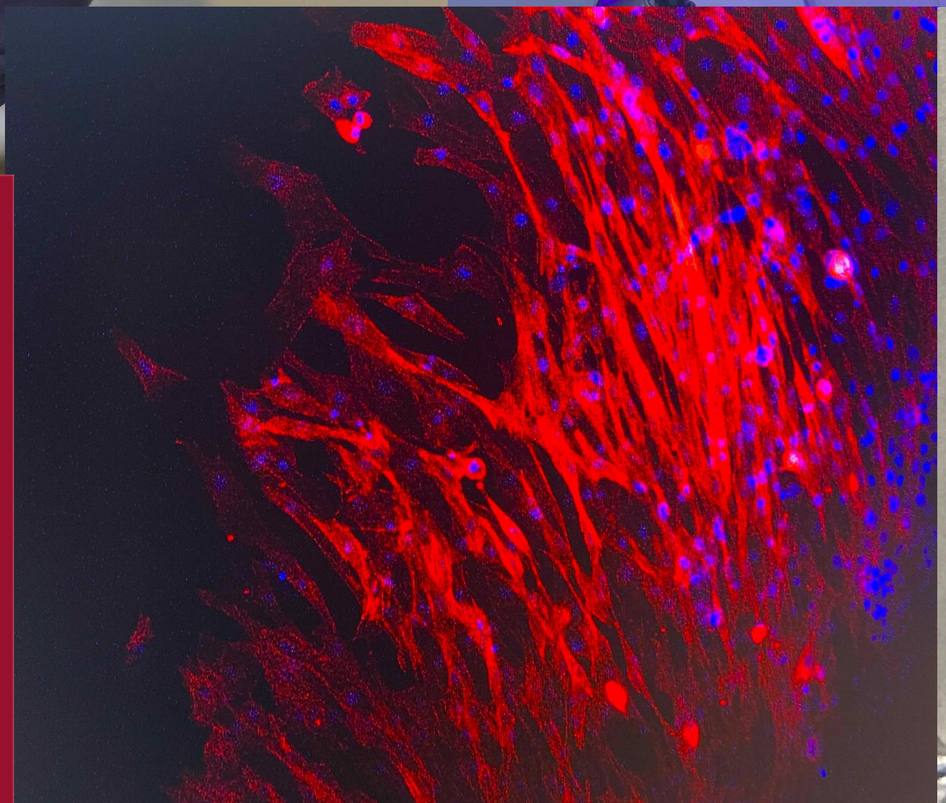

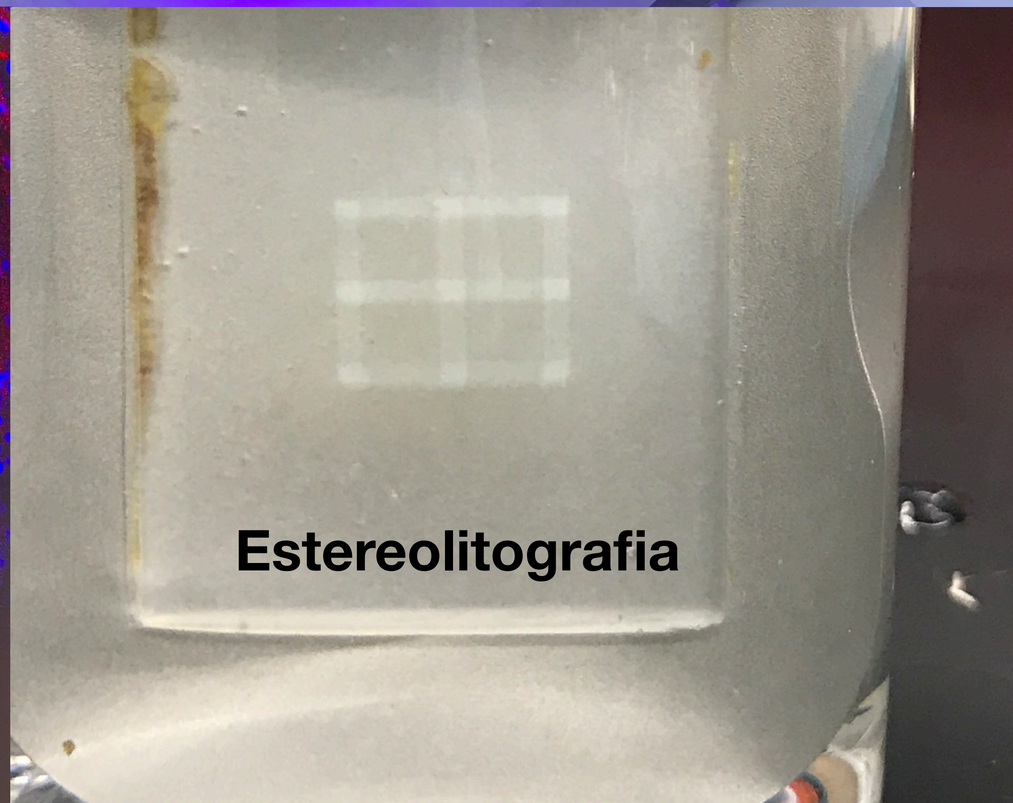

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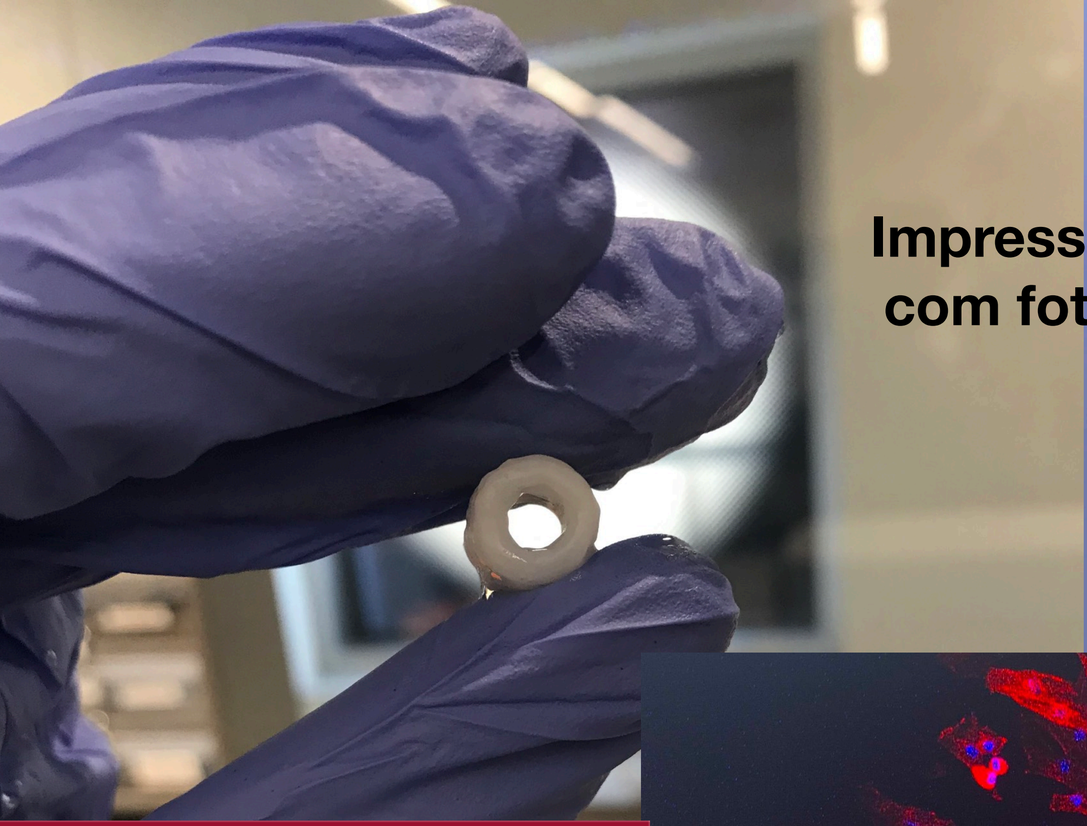

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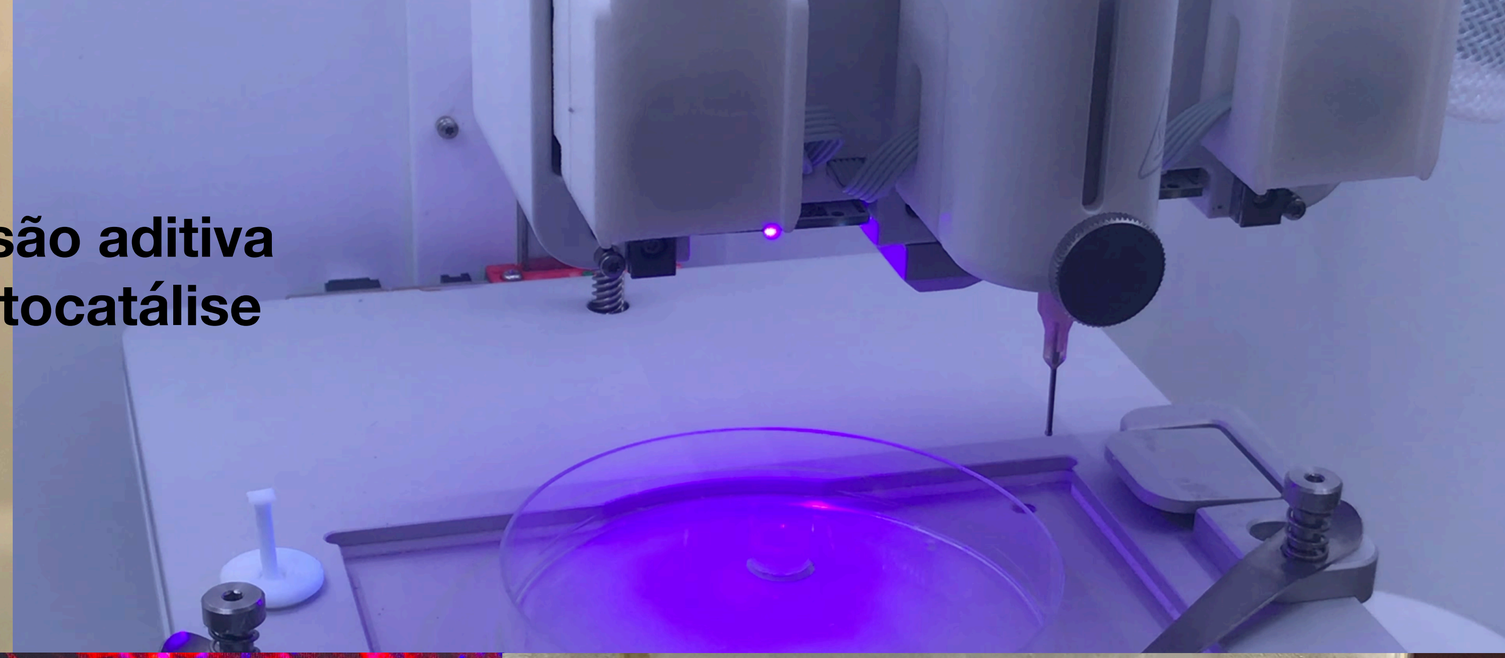

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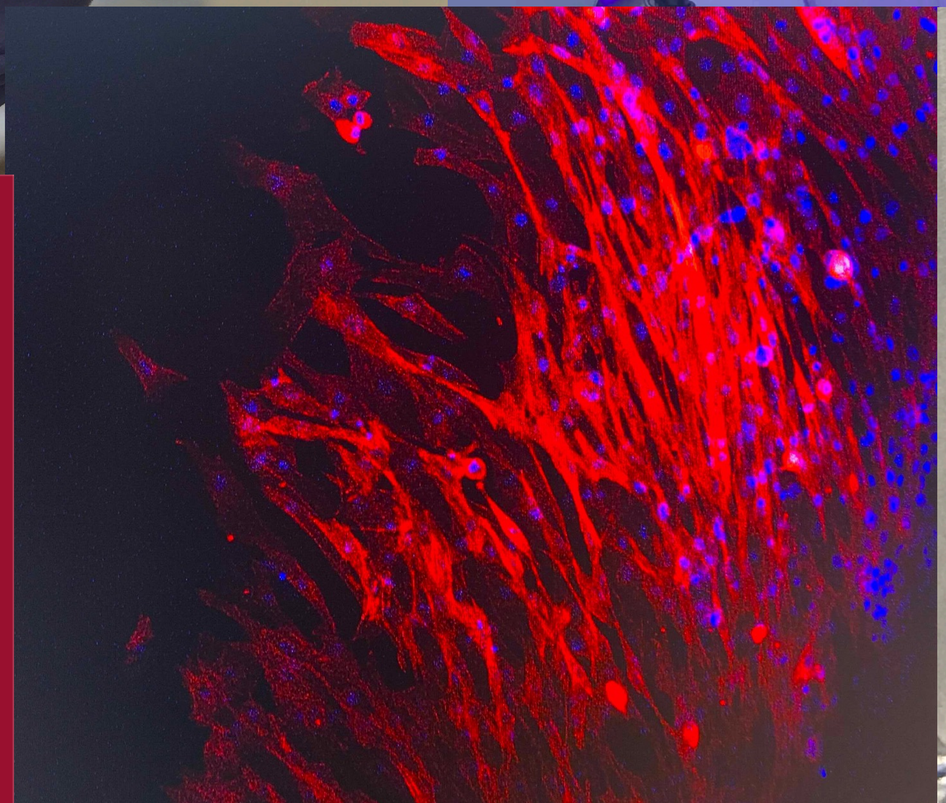

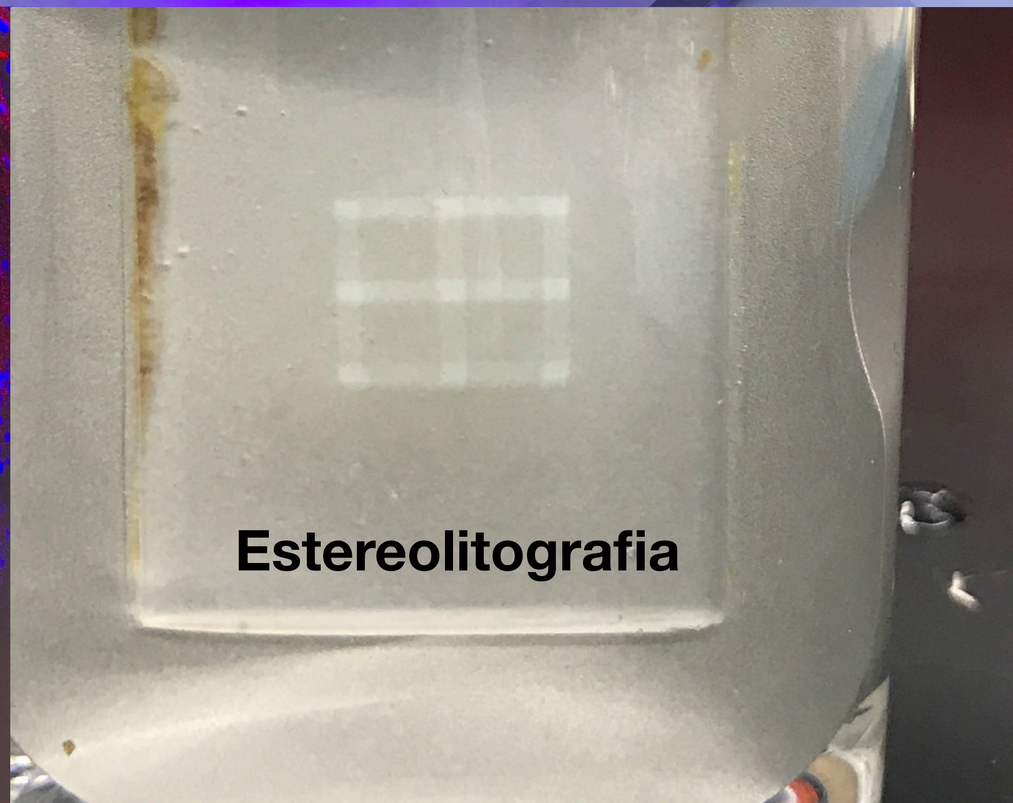

Estereolitografia

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Cesar Augusto Tischer

cesar.tischer@uel.br

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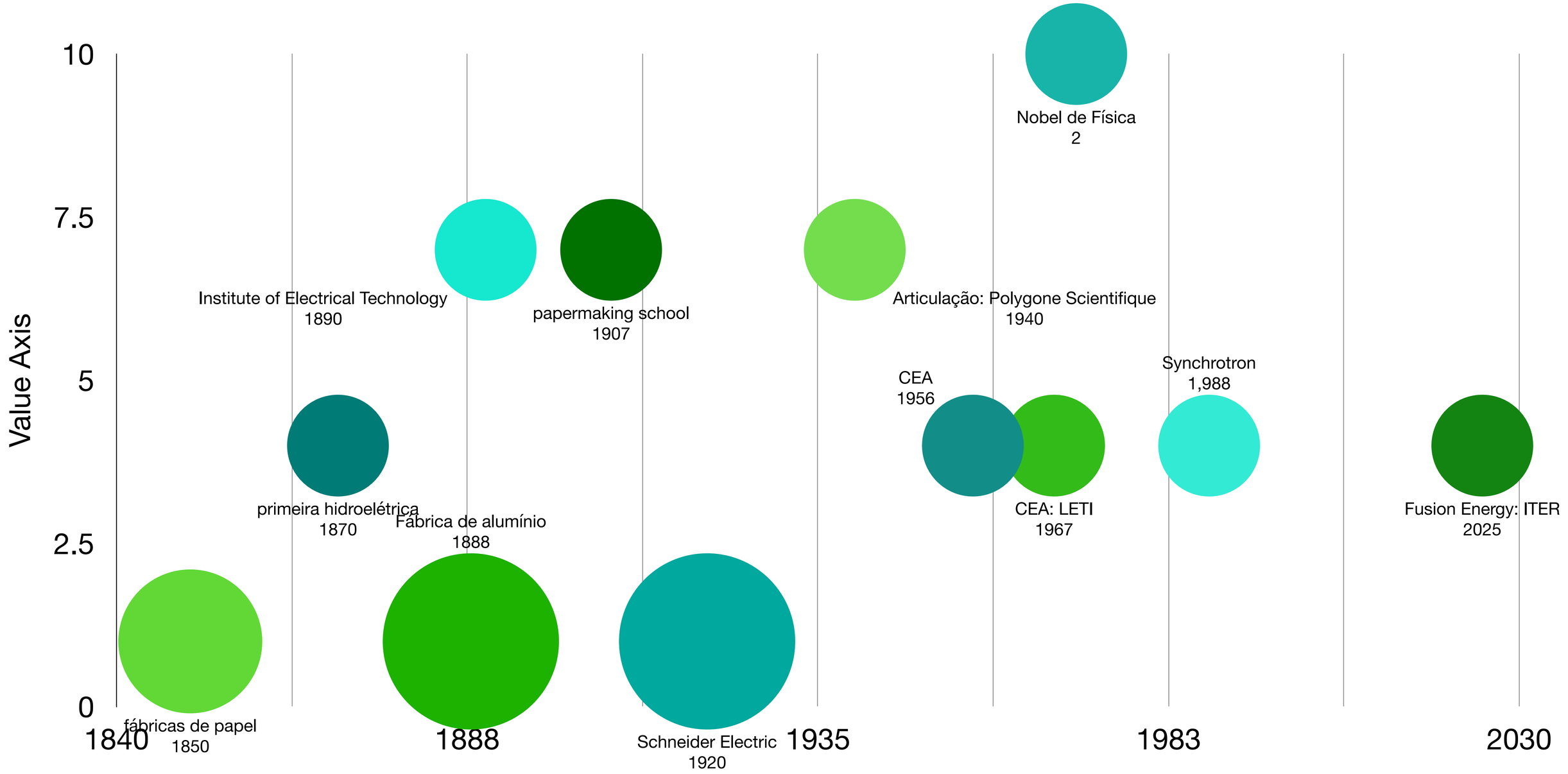
Cesar Augusto Tischer

cesar.tischer@uel.br

http://www.uel.br/pessoal/cesartischer/pesquisa

obrigado




Value Axis
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7.5
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Institute of Electrical Technology
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1907
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CEA
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Synchrotron
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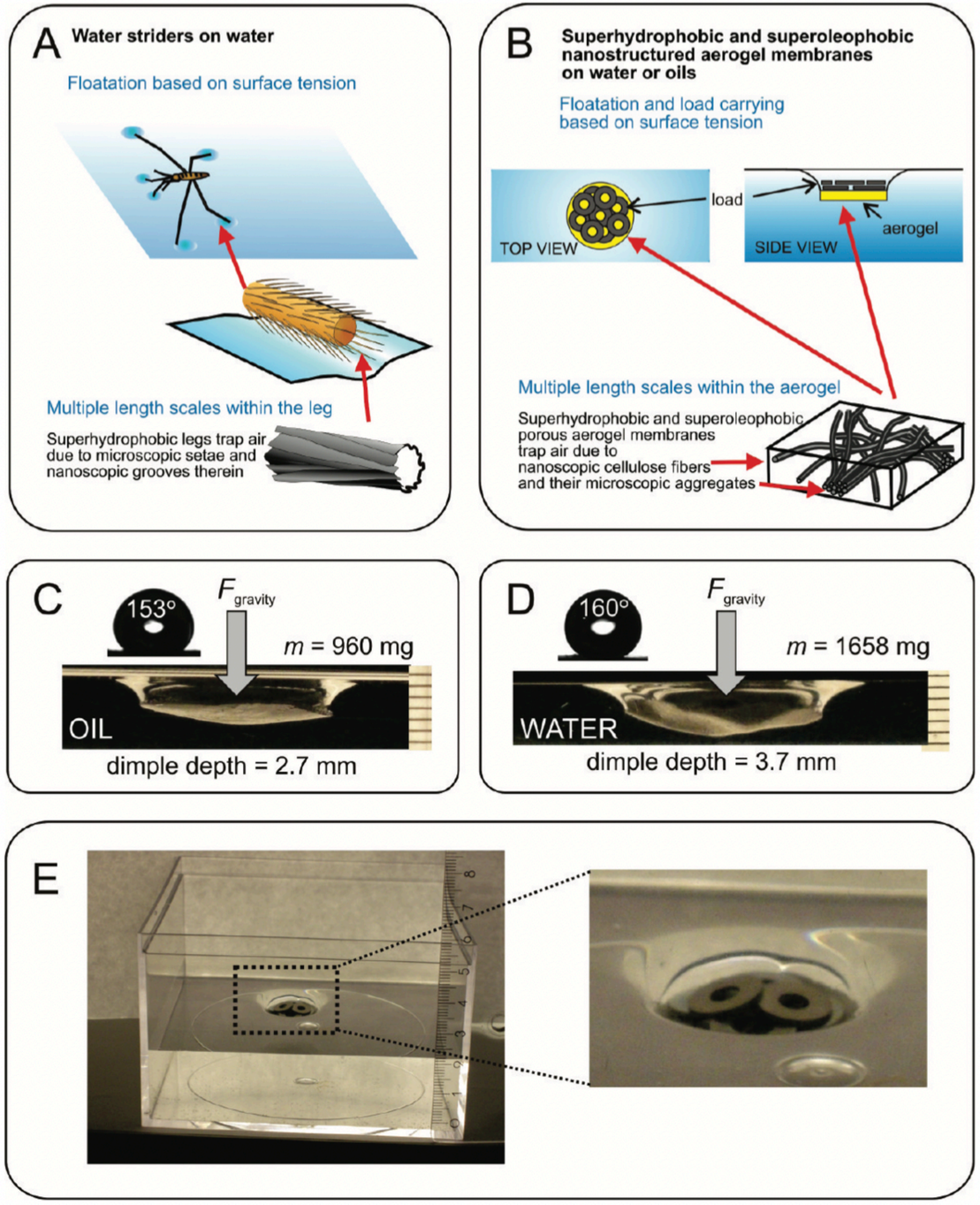
Schneider Electric
1920



- superfícies super apolares
- aerogéis



SUOMI – FINLAND



(12) **PATENTTIJULKAISU**
PATENTSKRIFT

(10) **FI 122230 B**

(45) Patentti myönnetty - Patent beviljats **31.10.2011**

(51) Kv.lk. - Int.kl.

Langmuir 2011, 27(5), 1930–1934