

Identifying the Creation and Impact of New Technologies in Patent Text

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Identifying the creation and impact of new technologies

- Creation and diffusion of new technologies key for productivity and growth
- Difficult to identify
 - Creation of new technologies
 - Impact on subsequent invention
- Patent statistics (Griliches 1990, Hall et al. 2001)
- Heterogeneity in novelty and impact (Trajtenberg 1990, ...)
 - Majority cover small incremental advances to existing technologies, little impact on subsequent invention
 - Small minority cover fundamentally new technologies with a major impact

Identifying the creation and impact of new technologies

- To measure novelty and impact
 - Patent classification (USPC)
 - Patent citations
- Limitations and bias
 - Classification (Thompson & Fox-Kean 2005, Arts et al. 2018, Righi & Simcoe 2019)
 - Citations (Alcacer & Gittelman 2006, Lampe 2012, Kuhn et al. 2017)
- Do not capture detailed technical content of a patent
- Cannot accurately identify new technologies and their impact on subsequent inventions

Natural language processing

- Harness technical content of patent documents
- All U.S. patents granted between March 1969 and May 2018 (n=6,252,916)
- Concatenate title, abstract, claims, lowercase, eliminate stop words, words<2 characters, numbers, words which appear only once, frequent non-technical terms, stemming
- 1,326,975 unique stemmed keywords, avg 61 per patent
- See Arts S, Cassiman B, Gomez JC. 2018. Text matching to measure patent similarity. *Strategic Management Journal* 39(1): 62–84.
 - <https://dataverse.harvard.edu/dataverse/patenttext>
 - https://github.com/jcgcaranza/smj_code

Identifying the creation and impact of new technologies

United States Patent [19]
Hull

[11] Patent Number: 4,575,331
[45] Date of Patent: Mar. 11, 1982

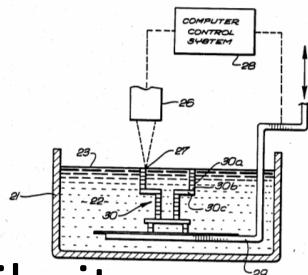
[54] APPARATUS FOR PRODUCTION OF THREE-DIMENSIONAL OBJECTS BY STEREO-LITHOGRAPHY
[75] Inventor: Charles W. Hull, Arcadia, Calif.
[73] Assignee: UVP, Inc., San Gabriel, Calif.
[21] Appl. No.: 638,905
[22] Filed: Aug. 8, 1984
[51] Int. Cl.⁴ B29D 11/00; G03C 00/00
[52] U.S. Cl. 425/174.4; 425/174; 425/162; 264/22; 430/269; 156/58; 365/119; 365/120
[58] Field of Search 425/162, 174, 174.4, 425/425; 264/22, 183, 40.1; 430/269; 156/38, 58, 275.5; 365/107, 119, 127
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3,775,036 11/1973 Winning 425/174.4
3,974,248 8/1976 Atkinson 425/162 X
4,041,476 8/1977 Swainson 365/119
4,073,229 3/1978 Swainson et al. 365/107
4,081,276 3/1978 Crivello 430/269
4,238,840 12/1980 Swainson 365/119

Primary Examiner—J. Howard Flint, Jr.
Attorney, Agent, or Firm—Fulwider, Patton, Rieber, Lee & Utecht

ABSTRACT

A system for generating three-dimensional objects by creating a cross-sectional pattern of the object to be formed at a selected surface of a fluid medium capable of altering its physical state in response to appropriate synergistic stimulation by impinging radiation, particle bombardment or chemical reaction, successive adjacent laminae, representing corresponding successive adjacent cross-sections of the object, being automatically formed and integrated together to provide a step-wise laminar buildup of the desired object, whereby a three dimensional object is formed and drawn from a substantially planar surface of the fluid medium during the forming process.

47 Claims, 8 Drawing Figures



United States Patent [19]
Gianturco

[11] Patent Number: 4,580,568
[45] Date of Patent: Apr. 8, 1986

[54] PERCUTANEOUS ENDOVASCULAR STENT AND METHOD FOR INSERTION THEREOF
[75] Inventor: Cesare Gianturco, Champaign, Ill.
[73] Assignee: Cook, Incorporated, Bloomington, Ind.
[21] Appl. No.: 656,261
[22] Filed: Oct. 1, 1984
[51] Int. Cl.⁴ A61M 29/00
[52] U.S. Cl. 128/345; 138/97; 604/96; 267/182
[58] Field of Search 128/345, 341, 343, 1 R, 128/334 R; 138/97, 119; 604/93, 96, 102, 104-107; 267/180, 182

Primary Examiner—Robert P. Swiatek
Attorney, Agent, or Firm—Woodard, Weikart, Emhardt & Naughton

ABSTRACT

An endovascular stent formed of stainless steel wire of 0.018 inches diameter and arranged in a closed zig-zag pattern. The stent is compressed into a reduced size shape of an outer diameter which is many times smaller than its expanded shape. The stent is positioned in a passageway in the vascular system by means of a sheath while the stent is retained in the compressed reduced size shape. A flat-ended catheter is used through the sheath to hold the stent in place in the passageway while the sheath is withdrawn from the passageway allowing the stent to expand in the passageway into its expanded shape to hold the passageway open and enlarged. Other possible applications of the stent are in the respiratory, biliary and urinary tracts to reinforce collapsing structures.

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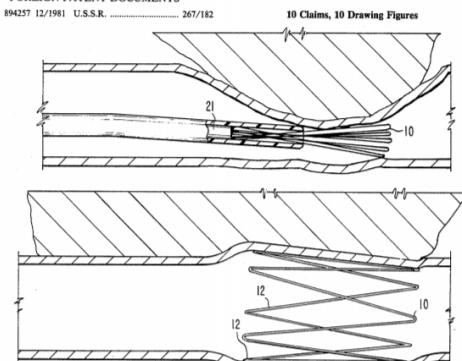
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Morris Simons, "Venu Cava . . . Memory Alloy", 89-94, Radiology, 10-1977.

Primary Examiner—Robert P. Swiatek
Attorney, Agent, or Firm—Woodard, Weikart, Emhardt & Naughton

ABSTRACT

An endovascular stent formed of stainless steel wire of 0.018 inches diameter and arranged in a closed zig-zag pattern. The stent is compressed into a reduced size shape of an outer diameter which is many times smaller than its expanded shape. The stent is positioned in a passageway in the vascular system by means of a sheath while the stent is retained in the compressed reduced size shape. A flat-ended catheter is used through the sheath to hold the stent in place in the passageway while the sheath is withdrawn from the passageway allowing the stent to expand in the passageway into its expanded shape to hold the passageway open and enlarged. Other possible applications of the stent are in the respiratory, biliary and urinary tracts to reinforce collapsing structures.



- New words (reuse)
 - Stereolithographi (US4575330)
 - 644 patents reuse

- New word combinations (reuse)
 - “vascular stent” (US4580568)
 - 2,063 patents reuse

- Backward and forward cosine similarity
 - Patent is vector of 1,326,975 dimensions, each dimension one keyword from vocabulary, value is frequency in patent
 - 1- avg backward= novelty
 - Forward/backward cosine= impact-weighted novelty

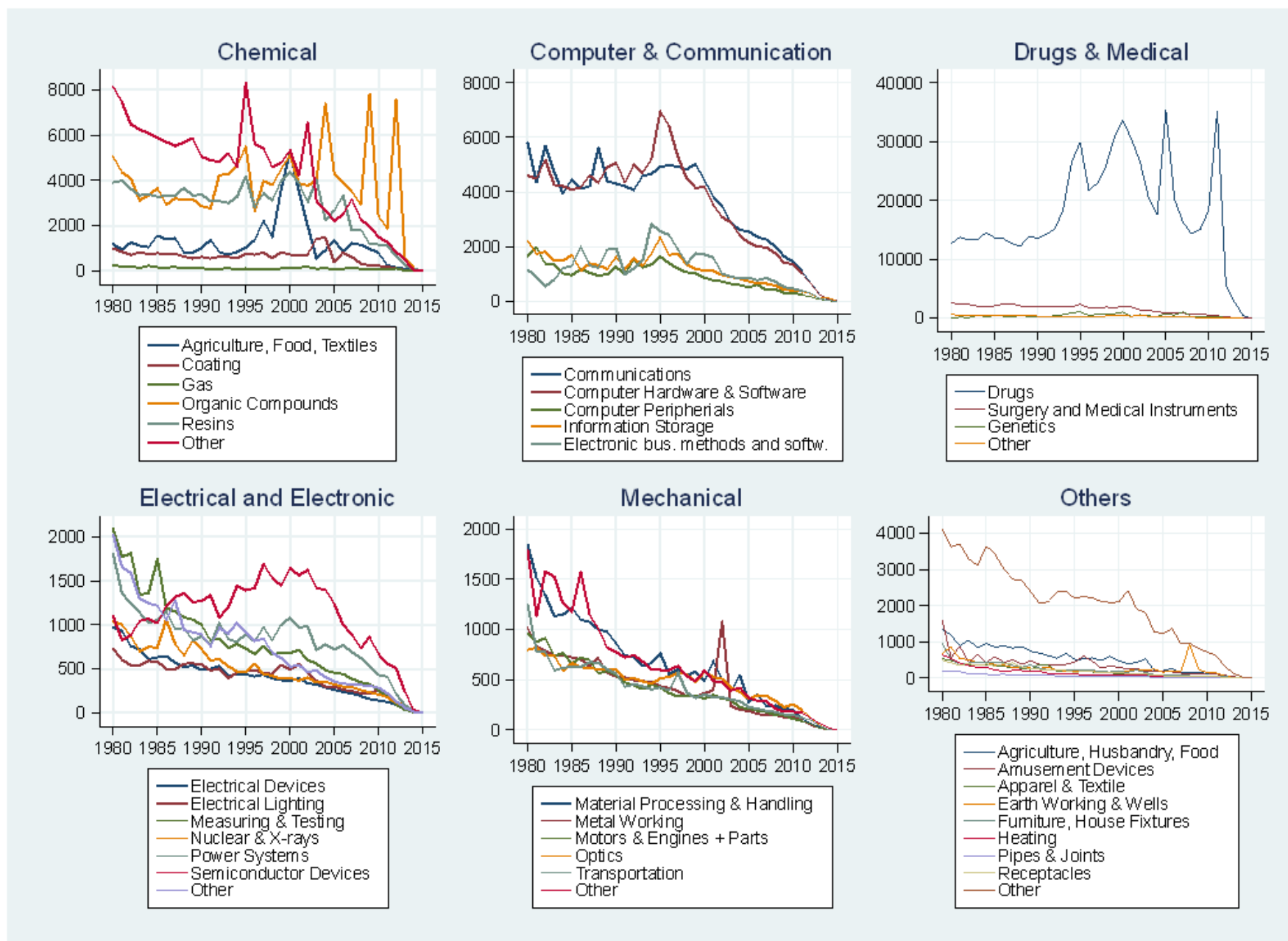
➤ Novelty versus impact weighted novelty

Table A.1: Most reused new words by technology field and five-year period

	Chemical	Computer & communication	Drug & medical	Electric & electronics	Mechanics	Others
1980-1984	glyphos (4927)	ethernet (13804)	transgen (18054)	workflow (4972)	processor-read (4538)	broker (3307)
	canola (2913)	proxi (13442)	alzheim (8193)	set-top (4504)	copd (1475)	dicamba (2945)
	pecyd (2880)	multicast (10847)	cytokine (7941)	voxel (3271)	nas (1451)	healthcar (2549)
	msc (2264)	timestamp (10340)	backcross (7400)	chipset (2636)	disambigu (1379)	timeline (2372)
	polyetheretherketon (2237)	tft (9364)	site-specif (5029)	pfet (2482)	superelast (1336)	mesopor (2047)
1985-1989	boxh (5915)	internet (74165)	antisens (8316)	computer-execut (42814)	laptop (9034)	spreadsheet (2742)
	microfluid (5148)	browser (22291)	neurodegen (4031)	ofdm (9046)	nanocryst (1994)	loyalti (1420)
	glufosin (4161)	markup (11739)	restenosis (3326)	lte (6062)	placeholder (1582)	eptf (761)
	nanostructure (4153)	e-mail (10453)	overexpress (2636)	asic (5741)	nanocrystallin (1414)	gameplay (646)
	wan (3099)	hypertext (7789)	vegf (2381)	kda (3867)	fiat (1060)	caplet (583)
1990-1994	nanotub (11373)	metadata (26384)	unicast (4269)	rfid (14489)	geo-loc (1195)	graphen (4500)
	umt (3033)	email (16936)	apoptosis (4095)	fpga (4813)	nano-s (1051)	forum (1157)
	paclitaxel (2886)	html (7021)	introgres (2608)	nanowir (4116)	omu (858)	block-bas (787)
	fulleren (2036)	qos (6154)	cdr3 (2068)	damascen (4105)	polyaxi (849)	och2ch3 (712)
	cds (1622)	mpeg (5065)	chemokin (2060)	microelectromechan (3616)	tialn (811)	paylin (678)
1995-1999	nanofib (1912)	bluetooth (12514)	irinotecan (921)	mtj (1631)	leftbracketingbar (490)	izo (1825)
	docetaxel (1494)	websit (11959)	c2-6alkenyl (901)	blog (1269)	auto-negoti (265)	nutraceut (1099)
	ppo-inhibitor (1101)	http (8152)	ch2f (874)	mpeg-4 (864)	vpls (259)	c6h4 (786)
	nanorod (878)	java (6053)	nr1lr12 (714)	gan-bas (810)	oadm (238)	electrospin (610)
	biodiesel (870)	wlan (5954)	c3-7cycloalkyl (712)	on-di (724)	osnr (237)	pcrf (608)
2000-2004	lipf (395)	wi-fi (4678)	siRNA (2513)	finfet (3238)	in-wheel (215)	imatinib (621)
	hfsion (367)	wifi (4597)	imidazalinon (1384)	mbms (906)	post-passiv (169)	nanoclay (300)
	cinr (310)	harq (2491)	stearyl-acp (1342)	through-silicon (823)	near-ey (145)	nanosheet (258)
	sorafenib (298)	wimax (2374)	broxynil (1234)	cnts (535)	rlsio3 (93)	wager-bas (211)
	co2ra (286)	malwar (2144)	mirna (1051)	hfsio (347)	wdm-pon (92)	cf2ch2 (176)
2005-2009	hvr-h2 (147)	cloud-bas (1844)	sunitinib (265)	tsvs (786)	img (308)	triphenylenen (102)
	hvr-l3 (146)	pucch (1599)	dasatinib (209)	igzo (440)	microsd (110)	phenalenylen (90)
	hvr-h3 (146)	femtoce (1066)	panitumumab (195)	netbook (404)	liah (52)	picenylen (86)
	hvr-h1 (146)	iptv (761)	lenalidomid (177)	package-on-packag (392)	olaparib (50)	azacarbazol (86)
	hvr-l2 (145)	csi-r (737)	sitagliptin (147)	through-silicon-via (281)	rsoa (49)	pentalenylen (86)
2010-2014	biochar (86)	openflow (289)	bicyclopiron (87)	imidazopyridinylen (50)	yc62 (19)	spiro-fluorenyl (104)
	aluminum-cadmium (59)	ul-dl (222)	hydroxyphenyl-pyruv (70)	imidazopyrimidinylen (48)	pseudo-euclidean (16)	spiro-fluorenylen (69)
	fluensulfon (51)	heve (220)	crizotinib (68)	fcvd (46)	yc52 (15)	aza-dibenzoselenophen (50)
	metazosulfuron (51)	csi-rss (131)	cv995128 (64)	contact-level (45)	cryptocurr (14)	smartpad (36)
	propyrisulfuron (48)	vxlan (128)	pta-11307 (64)	in-m-zn (42)	smartphone-oper (14)	bitcoin (25)

the most reused new words by technology field and five-year period. Each patent is assigned to an NBER category and five-year period based on primary class and filing year number of patents reusing the keyword is displayed between brackets.

Figure 3: New word combinations weighted by future reuse by NBER technology subcategory and filing year



Notes: The figures shows the total number of new word combinations weighted by future reuse by NBER subcategory and filing year (n= 4,708,680 patents). We

Validation text-based measures

- Patents linked to prestigious awards
 - Fundamentally new technologies, major impact on subsequent inventions
- Case-control design
 - Matched one-to-one to control patents
 - Technical content and filing dates
 - 259 *award* patents, 259 text-matched *control* patents
 - Likely cover small incremental advances little impact
- Ability to distinguish award and control patents
 - *t*-test, Cohen's *d*
 - Precision, recall, auc (area under ROC-curve)

Table 1: Sample Award Patents

Award	Period	# awards	# patents	# patents filed since 1980
Nobel Prize	1975-2018	305	80	59
Lasker Award	1975-2018	221	58	42
A.M. Turing Award	1975-2017	58	17	14
National Inventor Hall of Fame	1990-2018	130	112	60
National Medal of Technology and Innovation	1985-2014	226	76	42
Benjamin Franklin Medal	1998-2018	149	41	33
Bower Award	1990-2018	28	9	9
		1,117	393	259

United States Patent [19] [11] **Patent Number:** **5,910,382**
Goodenough et al. [45] **Date of Patent:** ***Jun. 8, 1999**

[54] **CATHODE MATERIALS FOR SECONDARY (RECHARGEABLE) LITHIUM BATTERIES**

[75] Inventors: **John B. Goodenough**, Austin, Tex.; **Akshaya K. Padhi**, LaSalle, Ill.; **K. S. Nanjundaswamy**, Joplin, Mo.; **Christian Masquelier**, Boulogne Billancourt, France

[73] Assignee: **Board of Regents, University of Texas Systems**, Austin, Tex.

[21] Appl. No.: **08/840,523**
 [22] Filed: **Apr. 21, 1997**

Related U.S. Application Data

[60] Provisional application No. 60/032,346, Dec. 4, 1996, and provisional application No. 60/016,060, Apr. 23, 1996.

[51] **Int. Cl.⁶** **H01M 4/58**
 [52] **U.S. Cl.** **429/218.1; 429/221; 429/224**
 [58] **Field of Search** **429/218, 221, 429/224; 29/623.1; 423/554**

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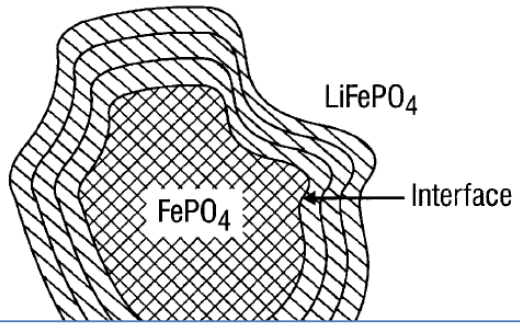
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Primary Examiner—Maria Nuzzolillo
Assistant Examiner—Carol Chaney
Attorney, Agent, or Firm—Arnold White & Durkee

[57] **ABSTRACT**

The invention relates to materials for use as electrodes in an alkali-ion secondary (rechargeable) battery, particularly a lithium-ion battery. The invention provides transition-metal compounds having the ordered-olivine or the rhombohedral NASICON structure and the polyanion (PO₄)³⁻ as at least one constituent for use as electrode material for alkali-ion rechargeable batteries.

9 Claims, 10 Drawing Sheets



- John Goodenough 2018 Benjamin Franklin Medal
- Rechargeable lithium-ion battery
- US5910382
 - “lifepo4” (lithium ion phosphate) reused by 260 patents
 - “batteri lifepo4”, reused by 211 patents



(12) **United States Patent**
Horvath et al.

(10) **Patent No.:** US 9,951,341 B2
(45) **Date of Patent:** Apr. 24, 2018

(54) **LACTOCOCCUS CRISPR-CAS SEQUENCES**
(75) Inventors: **Philippe Horvath**, Chatellerault (FR);
Dennis Romero, Oregon, WI (US);
Anne M. Millen, Madison, WI (US)
(73) Assignee: **DUPONT NUTRITION**
BIOSCIENCES APS (DK)
(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 467 days.

(21) Appl. No.: **13/880,391**
(22) PCT Filed: **Oct. 20, 2011**
(86) PCT No.: **PCT/US2011/057102**
§ 371 (c)(1),
(2), (4) Date: **Jul. 3, 2013**
(87) PCT Pub. No.: **WO2012/054726**
PCT Pub. Date: **Apr. 26, 2012**

(65) **Prior Publication Data**
US 2013/0288251 A1 Oct. 31, 2013

Related U.S. Application Data
(60) Provisional application No. 61/394,976, filed on Oct.
20, 2010, provisional application No. 61/405,317,
filed on Oct. 21, 2010.

(51) **Int. Cl.**
C12N 15/74 (2006.01)
C07K 14/195 (2006.01)
(52) **U.S. Cl.**
CPC **C12N 15/746** (2013.01); **C07K 14/195**
(2013.01); **C12N 15/74** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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Primary Examiner — Nancy A Treptow

(57) **ABSTRACT**
The present invention relates to a nucleic acid comprising a
Lactococcus CRISPR repeat region and/or a *Lactococcus*
CRISPR spacer region.

27 Claims, 4 Drawing Sheets

- Philippe Horvath received the 2018 Bower Award and Prize for Achievement in Science
- Genome-editing tool CRISPR-Cas
- US9951341
 - “crispr-ca” reused by 19 patents
 - “transcript crispr” reused by 28 patents



Validation award patents

- Support the use of NLP
- Text-based novelty measures outperform traditional measures based on patent classification (USPC) and citations
 - new_subclass_comb, new_cit_comb, and originality
- Text-based impact-weighted novelty measures also outperform
 - new_subclass_comb_reuse, new_cit_comb_reuse
 - forward citations, generality
- New word comb (reuse) performs best

Validation rejected patents

- Patents issued by USPTO but rejected by EPO and JPO
 - USPTO grants too many invalid patents (Jaffe & Lerner 2004)
 - EPO/JPO examiners spend 2* more time, reject much larger share
 - Arguably lack novelty or cover incremental advances to existing technologies, little impact on subsequent inventions
- Case-control design
 - Matched one-to-one to control patents
 - Technical content and filing dates
 - 651,478 *granted* patents, 651,478 text-matched *rejected* patents
- Ability to distinguish granted and rejected patents
 - *t*-test, Cohen's *d*
 - Precision, recall, auc (area under ROC-curve)

Validation rejected patents

- Same findings
 - Support the use of NLP
 - Illustrate improvement over traditional measures based on patent classification and citations
- Again, new word comb (reuse) outperforms
- Predictive power lower compared to award sample
- USPTO indeed seems to grant invalid patents
 - Social costs might not outweigh social benefits related to disclosure and their effect on increasing subsequent invention (Lemley & Shapiro 2005)

Conclusion

- Identify creation and impact of new technologies
- Prior and current work mostly relies on patent classification and citations
- NLP to harness mostly unexplored technical content of patents
- Validated text-based measures and their improvement over traditional metrics
- We will provide open access to all code and cleaned data
 - Feel free to send me an email

Thanks!

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