

PATENTING OF 3D PRINTING & ADDITIVE MANUFACTURING

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Troy, Michigan

November 9, 2017

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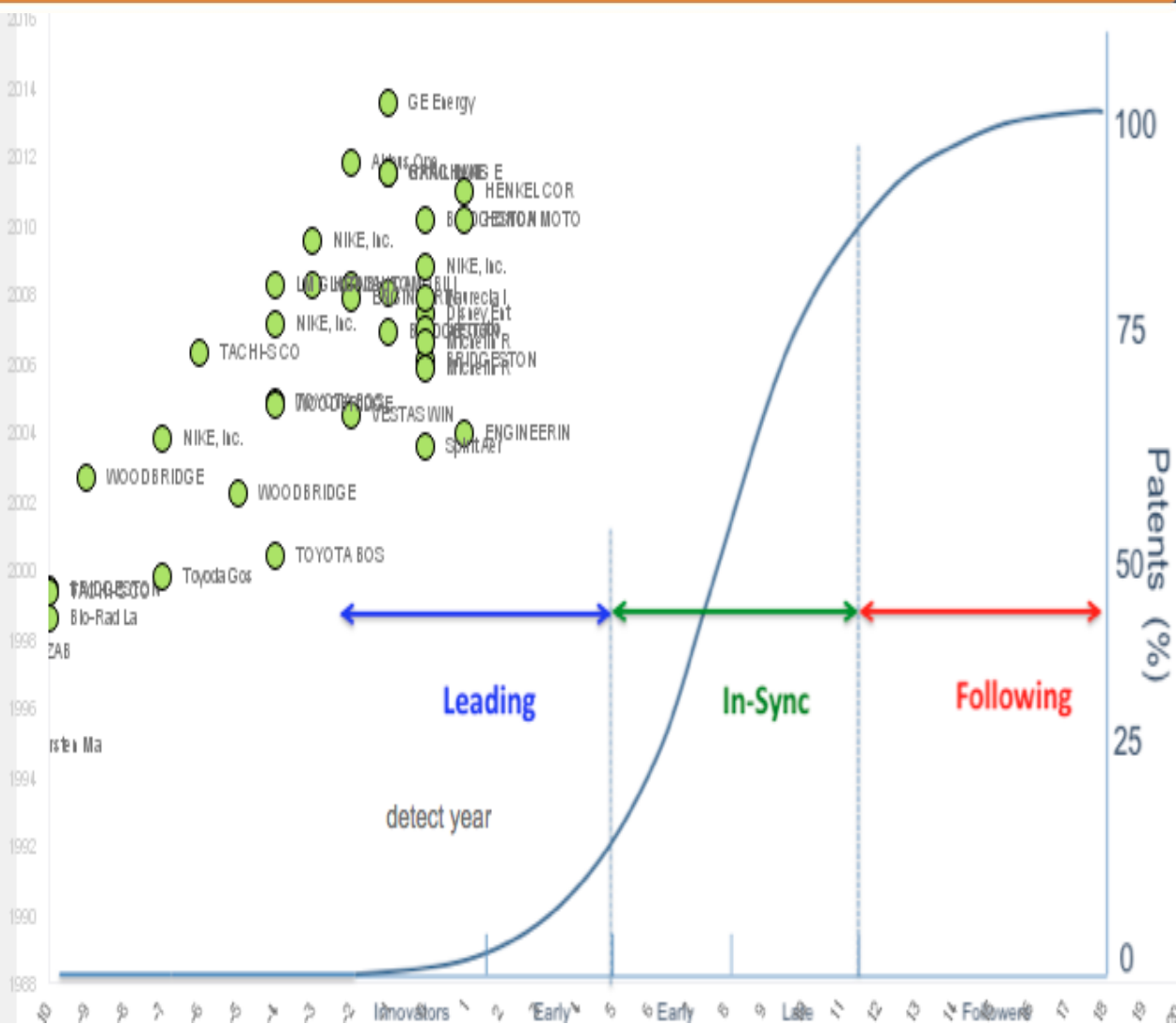
THREE DIMENSIONAL PRINTING PATENTS

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- Patenting 3DP machines
- Patenting 3DP software
- Patenting 3DP materials
- Patenting 3DP manufactured parts – is there a synergistic advantage to overcoming a traditional problem?
 - Circumventing die locks
 - Uniquely blended/placed multi-materials to cause “living hinge” or flexible seal in otherwise rigid structures
 - Creating totally enclosed hollow structures

US PATENT APPLICATIONS CLAIMING POSITIONING REINFORCEMENTS IN MATERIALS (E.G., 3DP SUPPORTS) – EMERGING/DISRUPTIVE TECHNOLOGY S-CURVE ANALYTICS

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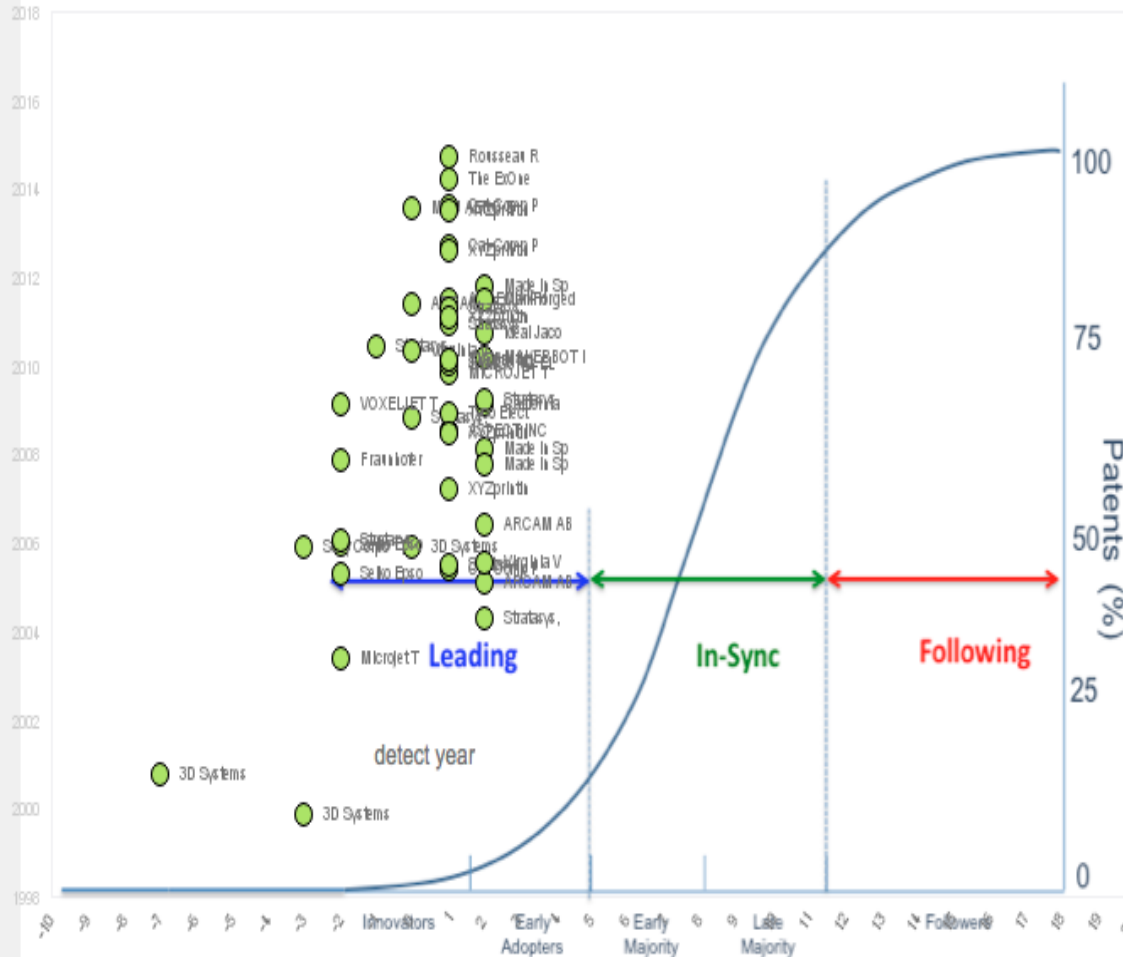


2016	TRANSGENOMIC, INC.	1999-06-02
	BBI BioSeq, Inc., a Massachusetts corporation	2001-07-03
	HEALTHLINX LIMITED	2002-08-23
2014	Universiteit Gent	2003-02-13
	SAIKA TECHNOLOGICAL INSTITUTE FOUNDATION	2003-12-05
2012	Beyond Genomics	2004-02-06
	BBI BioSeq, Inc., a Massachusetts corporation	2004-08-16
2010	CENTENNIAL TECHNOLOGY COMPANY	2004-10-13
	Waters Investments Limited	2005-08-17
	Applera Corporation	2006-02-09
2008	Systeme Analytique Inc.	2006-02-22
	SUMITOMO SEIKA CHEMICALS CO., LTD.	2006-05-09
2006	Brooks Rand LLC	2007-08-01
	Sekisui Chemical Co., Ltd.	2008-03-31
	ALBERTA RESEARCH COUNCIL INC.	2008-10-27
2004	SUMIKA CHEMICAL ANALYSIS SERVICE, LTD.	2008-12-11
	Waters Technologies Corporation	2009-02-20
	BROOKS RAND LABS, LLC	2009-06-29
2002	SEER TECHNOLOGY, INC.	2009-07-16
	FUSO PHARMACEUTICAL INDUSTRIES, LTD.	2010-09-14
2000	The Boards of Trustees of the Leland Stanford Junior University	2010-10-12
	S.T.I. Security Technology Integration Ltd.	2010-12-07
1998	National Institute of Advanced Industrial Science and Technology	2011-02-28
	GE HEALTHCARE BIO-SCIENCES AB	2011-03-31
1996	The Regents of the University of Colorado, a body coporate	2011-07-14
	Millipore Corporation	2011-12-06
1994	Commissariat a l'energie atomique et aux ene alt	2012-03-29
	Wyatt Technology Corporation	2012-05-24
1992	BROOKS RAND INC	2013-03-29
	Northeastern University	2013-07-31
1990	EMD MILLIPORE CORPORATION	2013-12-18
	IDEX HEALTH & SCIENCE LLC	2014-03-17

US PATENT APPLICATIONS CLAIMING CONTROLS FOR ADDITIVE MANUFACTURING (E.G., SELECTIVE LASER SINTERING) EMERGING/DISRUPTIVE TECHNOLOGY S-CURVE ANALYTICS

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Emerging Technology Evaluation



3D Systems, Inc.	2005-03-09
3D Systems, Inc.	2009-02-27
Sony Corporation	2009-09-02
Seiko Epson Corporation	2010-03-02
Fraunhofer-Gesellschaft zur Foerderung der angewandten Forschung e. V.	2010-05-11
VOXELJET TECHNOLOGY GMBH	2010-07-13
Microjet Technology Co., Ltd.	2010-08-31
Stratys, Inc.	2010-09-22
Stratys, Inc.	2011-12-22
MTU AERO ENGINES AG	2012-04-13
ARCAM AB	2012-05-11
Virginia Venture Industries, LLC	2012-08-09
3D Systems, Inc.	2012-09-25
Stratys, Inc.	2012-12-07
Tyco Electronics Corporation	2013-04-04
The Boeing Company	2013-07-24
Cal-Comp Precision (Singapore) Limited	2013-08-02
MICROJET TECHNOLOGY CO., LTD	2013-08-16
ASPECT INC.	2013-08-19
APRECIA PHARMACEUTICALS COMPANY	2013-09-03
The ExOne Company	2013-09-12
Stratys, Inc.	2013-09-13
SAMSUNG ELECTRONICS CO., LTD.	2013-10-02
Stratys, Inc.	2013-10-04
Rousseau Research, Inc.	2013-10-11
XYZprinting, Inc.	2013-11-08
XYZprinting, Inc.	2013-11-13
Stratys, Inc.	2014-01-03
MAKERBOT INDUSTRIES, LLC	2014-03-13
Virginia Venture Industries, LLC	2014-04-03
ARCAM AB	2014-04-03
ARCAM AB	2014-04-15
Ideal Jacobs Corporation	2014-05-07
Stratys, Inc.	2014-05-27
California Institute of Technology	2014-07-15
Made In Space, Inc.	2014-07-15
Made In Space, Inc.	2014-10-21
MarkForged, Inc.	2014-12-18

US PATENT APPLICATIONS CLAIMING MATERIALS TESTING EMERGING/DISRUPTIVE TECHNOLOGY S-CURVE ANALYTICS – IS THERE A POTENTIAL LINK WITH ADDITIVE MANUFACTURING???

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Emerging Technology Evaluation

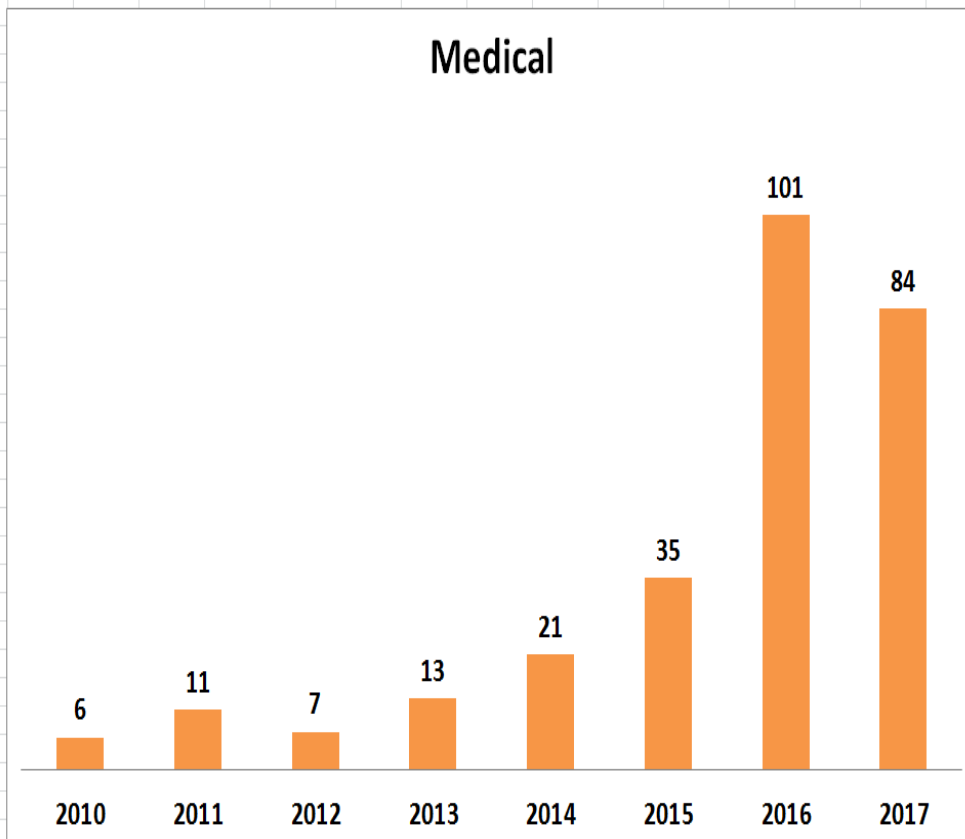


SUMITOMO CHEMICAL COMPANY, LIMITED	12/27/1988
JOHNSON LEVEL & TOOL MFG. CO., INC.	03/30/1999
Nikon Corporation	12/16/1999
THE ELIZABETH AND SANDOR VALYI FOUNDATION, INC.	03/15/2000
Karsten Manufacturing Corporation	01/31/2001
Bio-Rad Laboratories, Inc.	03/11/2002
TACHI-S CO., LTD.	11/08/2002
BRIDGESTONE CORPORATION	12/25/2002
WOODBIDGE FOAM CORPORATION	02/24/2003
NIKE, Inc.	04/14/2005
Toyoda Gosei Co., Ltd.	07/27/2005
TACHI-S CO., LTD.	12/18/2006
WOODBIDGE FOAM CORPORATION	10/30/2007
NIKE, Inc.	01/17/2008
LM GLASFIBER A/S	08/14/2008
TOYOTA BOSHOKU KABUSHIKI KAISHA	10/29/2008
WOODBIDGE FOAM CORPORATION	12/22/2008
NIKE, Inc.	12/02/2009
HITACHI CABLE, LTD.	12/16/2009
ENGINEERING & RESEARCH ASSOCIATES, INC.	02/08/2010
AUTOMOBILI LAMBORGHINI S.p.A.	07/02/2010
VESTAS WIND SYSTEMS A/S	09/03/2010
Airbus Operations GmbH	11/08/2010
BRIDGESTONE CORPORATION	01/06/2011
GRAIL INVENTIONS (PTY) LTD	02/21/2011
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HANCHANG ENPLA CO., LTD.	11/17/2011
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NIKE, Inc.	03/30/2012
Disney Enterprises, Inc.	04/18/2012
Faurecia Interieur Industrie	04/25/2012
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International Business Machines Corporation	07/31/2012
Michelin Recherche et Technique S.A.	11/27/2012
ENGINEERING & RESEARCH ASSOCIATES, INC.	02/20/2013
HONDA MOTOR CO., LTD.	03/01/2013
HENKEL CORPORATION	03/14/2013

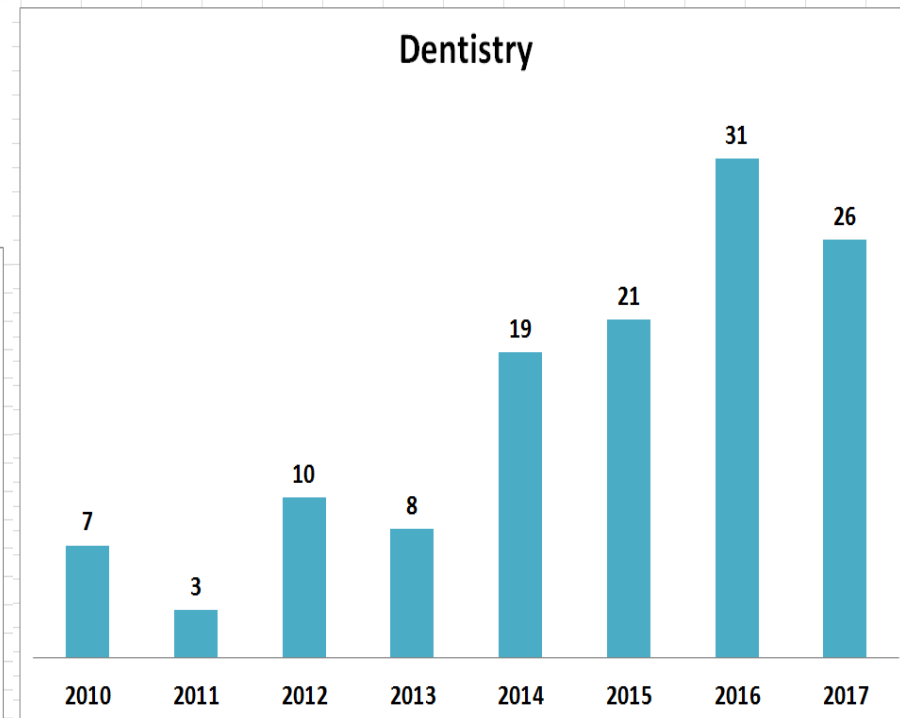
INDUSTRY-SPECIFIC 3DP PATENT PUBLICATIONS

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Medical



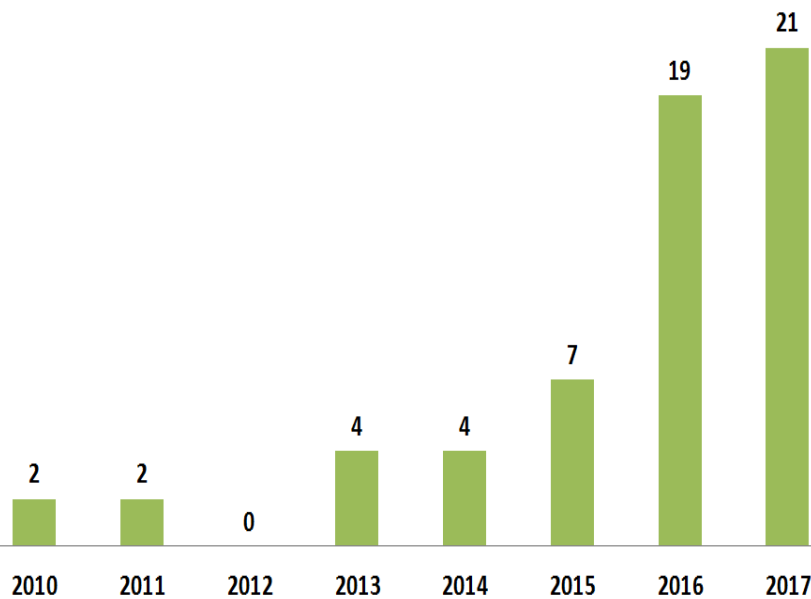
Dentistry



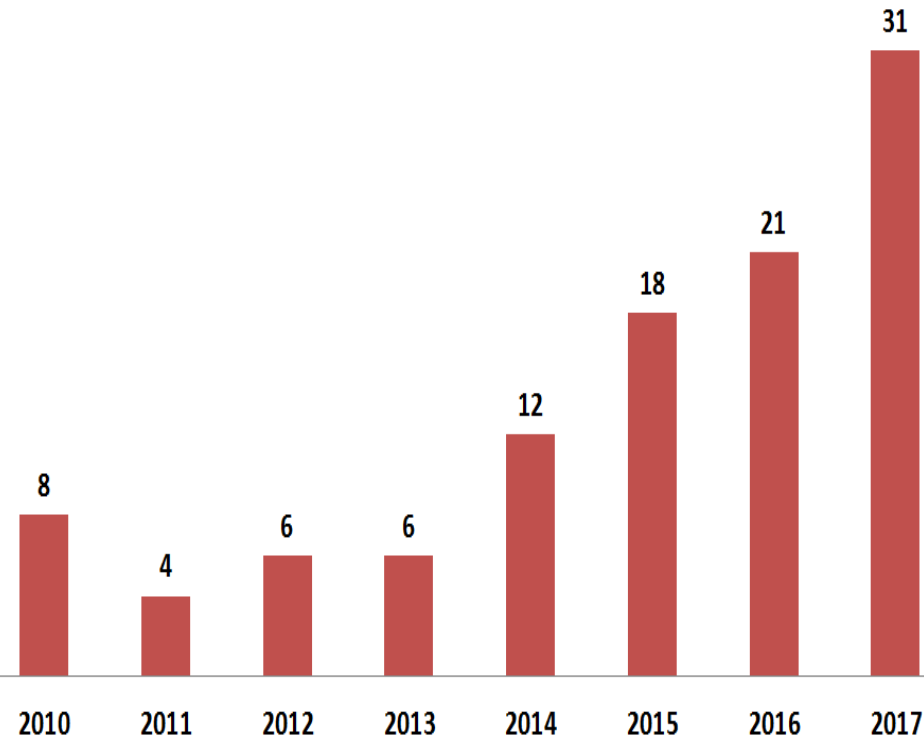
INDUSTRY-SPECIFIC 3DP PATENT PUBLICATIONS

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Aerospace



Automotive



YOUR COMPETITORS ARE FILING PATENT APPLICATIONS TO LOCK UP 3DP – ARE YOU?

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(12) **United States Patent** US 8,916,085 B2
Jackson et al. (45) **Date of Patent:** Dec. 23, 2014

(54) **PROCESS OF MAKING A COMPONENT WITH A PASSAGEWAY**

(75) Inventors: **Nicholas Jackson**, Davisburg, MI (US); **Todd L. Hemingway**, Metamora, MI (US); **Walter B. Pipp, Jr.**, Birmingham, MI (US)
 (73) Assignee: **A. Raymond et Cie**, Grenoble (FR)
 (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 694 days.

(21) Appl. No.: **13/151,397**
 (22) Filed: **Jun. 2, 2011**
 (65) **Prior Publication Data**
 US 2012/030449 A1 Dec. 6, 2012

(51) **Int. Cl.**
B29C 35/08 (2006.01)
B29C 41/02 (2006.01)
B29C 67/00 (2006.01)
F21S 8/10 (2006.01)
F21V 23/00 (2006.01)
F21K 99/00 (2010.01)
F21V 7/22 (2006.01)
F21V 101/02 (2006.01)
U.S. Cl.
 CPC **B29C 67/0059** (2013.01); **B29C 67/0055** (2013.01); **B29C 67/0062** (2013.01); **F21V 29/248** (2013.01); **F21K 9/13** (2013.01); **F21V 7/22** (2013.01); **F21V 2101/02** (2013.01); **F21S 48/325** (2013.01)
 USPC **264/401**; **264/297.8**; **264/308**; **264/494**
 (58) **Field of Classification Search**
 USPC **264/297.8**, **308**, **401**, **494**, **497**
 See application file for complete search history.

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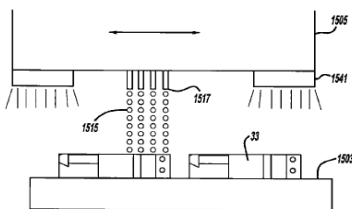
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Primary Examiner — Leo B Tentoni
 (74) *Attorney, Agent, or Firm* — Harness, Dickey & Pierce, P.L.C.

(57) **ABSTRACT**
 A component is provided that includes at least one passageway. In another aspect, a component, such as a lump or a vehicular washer jet, is made of layers of material, a light curable material and/or multiple built-up materials. Another aspect uses a three-dimensional printing machine to emit material from an ink jet printing head to build up a component.

37 Claims, 7 Drawing Sheets



(12) **United States Patent** US 9,278,465 B1
Worsley et al. (45) **Date of Patent:** Mar. 8, 2016

(54) **SYSTEM AND METHOD FOR 3D PRINTING OF AEROGELS**

(71) Applicant: **Lawrence Livermore National Security, LLC**, Livermore, CA (US)
 (72) Inventors: **Marcus A. Worsley**, Hayward, CA (US); **Eric Dross**, Dublin, CA (US); **Joshua Kuntz**, Livermore, CA (US); **Christopher Spadacini**, Livermore, CA (US); **Cheng Zhu**, Livermore, CA (US)
 (73) Assignee: **Lawrence Livermore National Security, LLC**, Livermore, CA (US)
 (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 3 days.

(21) Appl. No.: **14/481,362**
 (22) Filed: **Sep. 9, 2014**

(51) **Int. Cl.**
C23F 1/02 (2006.01)
B29C 41/00 (2006.01)
C01B 31/04 (2006.01)
B29L 9/00 (2006.01)
B33Y 10/00 (2015.01)
B33Y 30/00 (2015.01)
B33Y 70/00 (2015.01)
 (52) **U.S. Cl.**
 CPC **B29C 41/003** (2013.01); **C01B 31/043** (2013.01); **B29L 2009/00** (2013.01); **B33Y 10/00** (2014.12); **B33Y 30/00** (2014.12); **B33Y 70/00** (2014.12)
 (58) **Field of Classification Search**
 None
 See application file for complete search history.

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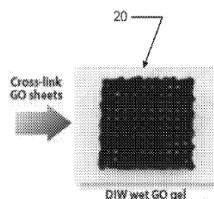
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 Shin, Swane J. et al. "Mechanical Deformation of Carbon Nanotube-Based Aerogels," Carbon 50 (2012), DOI: 10.1016/j.carbon.2012.06.044, 3 pages.
 Worsley, Marcus A. et al. "Mechanically Robust 3D Graphene Macroassembly with High Surface Area," Chem. Commun., 2011 No. 48, 8428-8430, 3 pages.

* cited by examiner
Primary Examiner — Shanim Ahmed
 (74) *Attorney, Agent, or Firm* — Harness, Dickey & Pierce

(57) **ABSTRACT**
 A method of forming an aerogel. The method may involve providing a graphene oxide powder and mixing the graphene oxide powder with a solution to form an ink. A 3D printing technique may be used to write the ink into a catalytic solute that is contained in a fluid containment member to form a wet part. The wet part may then be cured in a sealed container for a predetermined period of time at a predetermined temperature. The cured wet part may then be dried to form a finished aerogel part.

19 Claims, 3 Drawing Sheets



DIW structure maintains integrity through gelation, sacrificial drying, and thermal reduction

(12) **United States Patent** US 9,180,029 B2
Hollister et al. (45) **Date of Patent:** Nov. 10, 2015

(54) **POROUS BIDIRECTIONAL BELLOWS TRACHEAL RECONSTRUCTION DEVICE**

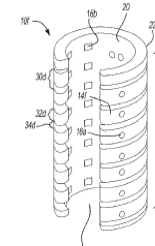
(71) Applicant: **THE REGENTS OF THE UNIVERSITY OF MICHIGAN**, Ann Arbor, MI (US)
 (72) Inventors: **Scott J. Hollister**, Saline, MI (US); **Glenn E. Green**, Dexter, MI (US)
 (73) Assignee: **The Regents Of The University Of Michigan**, Ann Arbor, MI (US)
 (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 35 days.

(21) Appl. No.: **13/715,715**
 (22) Filed: **Dec. 14, 2012**

(65) **Prior Publication Data**
 US 2013/0158651 A1 Jun. 20, 2013
Related U.S. Application Data
 (60) Provisional application No. 61/570,568, filed on Dec. 14, 2011.

(51) **Int. Cl.**
A61F 2/048 (2013.01)
A61F 2/94 (2013.01)
 (Continued)

(52) **U.S. Cl.**
 CPC . **A61F 2/048** (2013.01); **A61F 2/94** (2013.01); **A61L 31/005** (2013.01); **A61L 31/06** (2013.01); **A61L 31/148** (2013.01); **A61F 2002/043** (2013.01); **A61F 2002/044** (2013.01); **A61F 2002/046** (2013.01); **A61F 2220/0075** (2013.01); **A61F 2220/0091** (2013.01)
 (58) **Field of Classification Search**
 CPC **A61F 2/04**; **A61F 2/02**; **A61F 2/06**;
18 Claims, 17 Drawing Sheets



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