

基于知识图谱的柔性版印刷技术应用专利数据挖掘

宗利永¹, 肖颖¹, 麻祥才¹, 王晓红²

(1.上海出版印刷高等专科学校, 上海 200093; 2.上海理工大学, 上海 200093)

摘要: **目的** 为了对柔性版印刷关键技术的演进路径及研发热点进行知识挖掘。**方法** 以德温特专利数据库(DII)收录的柔性版印刷技术相关专利为数据源, 借助信息可视化软件 CiteSpace 对所采集的专利数据进行计量和可视化分析。**结果** 利用 CiteSpace 软件提供的词频探测技术绘制了柔性版印刷技术的研发热点和前沿知识图谱, 识别了柔印领域的技术热点。通过聚类可以发现专利文献聚焦范围主要集中在印刷版材制作、印刷油墨、印刷设备和柔性印刷电子等领域。研究焦点从最初的柔性版印刷的油墨和喷墨印刷研究领域, 逐渐出现了对印版制版的研究, 后续又围绕着印刷设备的各个部分产生了新的研发热点, 如控制系统、触屏、飞达和装帧部分。**结论** 基于专利知识图谱分析可以应用到柔性版印刷技术的知识管理过程中, 能为柔印行业探测学科前沿、开展知识服务提供决策依据和技术支撑。

关键词: 知识图谱; CiteSpace; 柔性版印刷技术; 专利挖掘

中图分类号: TP311 **文献标识码:** A **文章编号:** 1001-3563(2019)13-0259-09

DOI: 10.19554/j.cnki.1001-3563.2019.13.038

Patent Data Mining for Flexographic Printing Technology Application Based on Knowledge Mapping

ZONG Li-yong¹, XIAO Ying¹, MA Xiang-cai¹, WANG Xiao-hong²

(1.Shanghai Publishing and Printing College, Shanghai 200093, China;

2.University of Shanghai for Science and Technology, Shanghai 200093, China)

ABSTRACT: The paper aims to study the evolution path and R & D hotspots of flexographic printing technology. The patent data was measured and visualized by CiteSpace with patents related to flexographic printing technology collected in Derwent Innovation Index (DII) as data sources. This paper drew a map of research and development hotspots and frontiers of flexographic printing technology, and identified the hotspots and frontiers of flexographic printing technology with word frequency detection technology provided by CiteSpace software. Through clustering, it can be found that the patent literature mainly focused on the production of printing plate, printing ink, printing equipment and flexible printing electronics and other fields. The research initially focused the field of ink and inkjet printing for flexible printing, followed by plate-making. In the next few years, new research hotspots emerged, such as control systems, touch screens, sheet feeding and binding, around various parts of the printing equipment. The flexographic printing technology based on patent knowledge map analysis can be applied to the knowledge management process, providing decision-making basis and technical support for flexographic industry to explore the frontiers of disciplines and provide knowledge services.

收稿日期: 2018-12-09

基金项目: “知识服务语境下的绿色印刷产业发展趋势研究”招标课题 (SAY-B1806); “柔版印刷绿色制版与标准化实验室”招标课题 (ZBKT201809)

作者简介: 宗利永 (1981—), 男, 博士, 上海出版印刷高等专科学校副教授, 主要研究方向为绿色印刷知识图谱。

通信作者: 王晓红 (1971—), 女, 博士, 上海理工大学教授, 主要研究方向为数字图像处理、印刷质量管理、数字水印、色彩管理与再现。

KEY WORDS: knowledge mapping; CiteSpace; flexographic printing technology; patent mining

柔性版印刷具有印刷材料适应性广、生产效率高、环保等特点,被印刷行业公认为最有前途的印刷方式之一,在欧美国家已经成为仅次于平版胶印的第二大印刷方式,主要应用于标签、软包装、纸盒、纸杯、瓦楞纸箱预印和书刊印刷等领域。据资料统计,美国包装材料的印刷中,柔版印刷占70%,在欧洲市场也占45%。柔性版印刷在包装行业中的增长速度每年达到4%~5%,而在美国每一年的增长速度都超过7%,营业额超过200亿美元。柔印产品的环保性能与经济附加值在包装行业已远超平印和凹印。在我国柔性版印刷也发展迅速,所占市场份额从原来的不到5%逐步增加至目前的8%左右,预计还将继续增加^[1-7]。

对近年来柔印行业的技术发展脉络进行分析,有助于梳理出该行业的发展路径与演化规律,这需要从巨量、纷繁复杂的专利数据库中挖掘出表达技术发展的关键表征。文中借助信息可视化软件CiteSpace对所采集的专利数据进行计量和可视化分析,以德温特专利数据库中的柔印版印刷为例,进行手工代码共现分析、手工代码的聚类分析以及专利权人合作网络分析,实现专利知识可视化的应用,基于知识图谱研究视角,为柔性印刷领域的技术应用热点挖掘提供决策参考。

1 关键技术及分析方法

使用CiteSpace^[8-9,12]对柔性版印刷相关技术领域的专利数据进行计量和可视化分析。该软件主要用于基于知识图谱的研究前沿与研究热点分析、关键词共词网络分析、作者共被引与作者合作网络分析、H指数相关研究、科学知识图谱与引文分析学、共被引网络的聚类分析、知识计量与专利分析、技术测度研究等。借助CiteSpace研究者可以通过对相关领域的专利情报分析出相关科技领域的发展动态与趋势^[10-11]。

德温特分类系统覆盖了20个学科领域,被细分成由学科代号和2位字符组成的类号,即德温特分类号,但是德温特分类号只能表示专利所属的大类,并不能详细反映专利涉及的具体技术领域。而德温特手工代码是由德温特的标引人员手动分配给各个专利的,来表示专利技术的创新点及其应用,其标识了详细的技术领域,有助于准确定位某专利所涉及的具体领域,也对技术前沿的识别提供了便利。

文中研究数据来源于德温特专利数据库。Derwent Innovations Index (DII) 将 Derwent World Patents Index (德温特世界专利索引,简称WPI) 与 Derwent Patents Citation Index (专利引文索引) 加以整合。该数据库信息来源于全球40多个专利机构,

详细记载了2000多万条专利信息。每条记录除了包含相关的同族专利信息,还包括由各个行业的技术专家进行重新编写的专利信息,如描述性的标题和摘要、新颖性、技术关键、优点等。还可查找专利引用情况,建立专利与相关文献之间的链接,因此,使用德温特专利数据库作为数据源,能够保证分析的合理性和数据的充分性。

为了增强搜索专利数据的完整性,在德温特专利数据库中,以("flexography"OR" flexoprinting" OR" flexo-printing" OR" flexo printing" OR" flexoprinter" OR" flexo-printer" OR" flexo printer" OR" flexographic printing")为检索式,对柔性版印刷的相关专利进行主题检索,时间跨度为1963—2017年。一共检索到相关专利6649条。笔者所在课题组将所用数据的德温特专利数据格式进行转换,得到CiteSpace可以处理的WOS格式。

2 柔性版印刷技术领域专利知识图谱分析

2.1 德温特手工代码共现网络图谱

德温特手工代码(MC)标识了详细的技术领域,有助于发现热点领域和技术前沿。将专利文献数据利用CiteSpace自带格式转换器进行转换并导入CiteSpace中。在CiteSpace软件中以category为节点,相关参数设置:年份选择为2008—2017年,时间切片为1年;术语来源为Title, Abstract, Author Keywords (DE);节点类型为Category (MC);修剪算法为Pathfinder-Pruning sliced networks;设定标准为top30。

运行CiteSpace软件,最终得到一个节点数为83,网络密度 $E=178$ (Density=0.0523)的专利德温特手工代码共现网络图谱,见图1。

图谱由代表德温特手工代码的节点和代码字母组成,图中节点圆环的大小与此手工代码被标记的频次数量有关,手工代码节点周围圆环大小与此手工代码被标记的频次成正比,其代码对应的领域越是柔印专利研究涉及程度较为深入的领域。

所有德温特手工代码中,被标记次数前20的手工代码见表1。从表1可以看出被标记次数最多的手工代码为G02-A04A,被标记379次。其对应的领域是Printing and writing inks,即印刷油墨。说明印刷油墨是柔印专利中涉及较多的领域。排名第2位的是G05-A02,被标记212次,其对应的领域是Letterpress and deep relief printing plates,即凸版印刷(柔印)印版,说明除了柔印油墨外,柔印版也是涉及较多的领域。排名第3的手工代码是A12-W07B,

其对应的领域是 Lithographic printing plates produced (electro) photographically, 即平板印刷的照相制版, 也是与制版相关的柔印领域。

使用聚类功能对共现图谱进行聚类操作, 得到共 10 个聚类 (Cluster#0—9)。选择 Title Terms 对得到

的聚类进行标签, 并利用 Log-likelihood ratio 算法。参数 Modularity $Q=0.6321$, 表明聚类内的各节点有较强的关联性。参数 Mean Silhouette=0.6926, 表明聚类内各节点对应的专利在内容上有较高的一致性。得到的共现聚类见图 2。

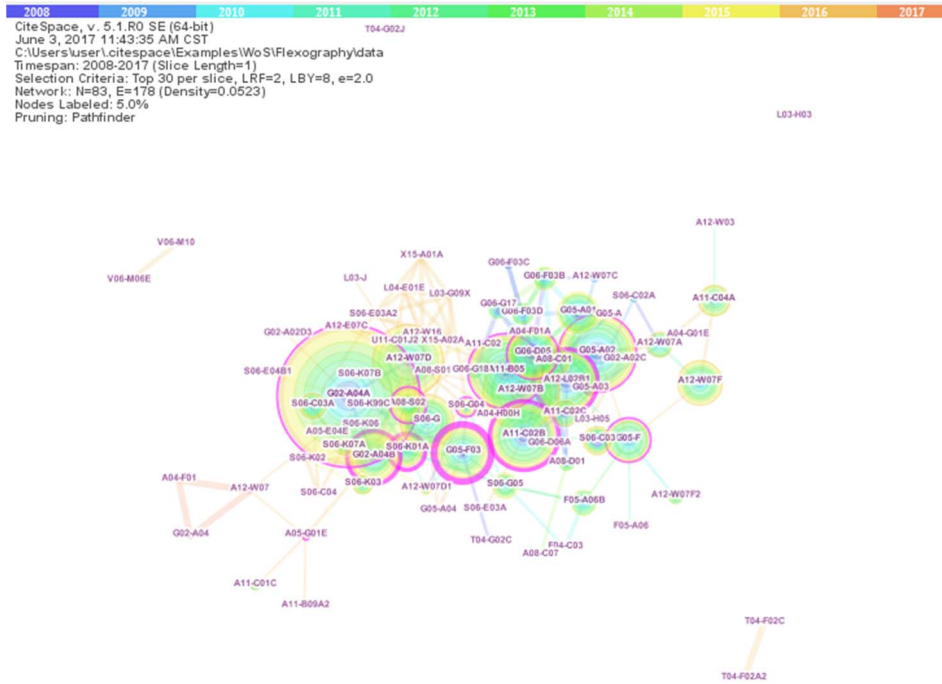


图 1 柔性版印刷领域专利的德温特手工代码共现网络图谱
Fig.1 Derwent's manual code co-existing network graph of flexographic printing patent

表 1 标记频次前 20 位的德温特手工代码
Tab.1 Derent's manual code for the top 20 frequency tags

Centrality	Year	MC	Translation
379	0.12	2008 G02-A04A	Printing and writing inks
212	0.16	2008 G05-A02	Letterpress and deep relief printing plates
211	0.04	2008 A12-W07B	Lithographic printing plates produced (electro)photographically
206	0.11	2008 A11-B05	Coating
202	0.1	2008 A12-W07D	Printing inks
177	0.36	2008 A11-C02B	Crosslinking with irradiation
174	0.2	2008 A12-L02B1	Compositions for making printing plates
162	0.07	2009 S06-G	Ink-Jet Image Production
157	0.53	2008 G05-F03	Ink jets/ink jet printing
152	0.2	2008 G06-D05	Production of printing plates
150	0.25	2008 G02-A04B	Dyes and pigments for inks, crayons
136	0.02	2008 A12-W07F	Other printing equipment/processes
129	0	2008 G05-A01	Lithographic (planographic) printing plates
122	0.17	2008 G05-F	Other printing materials and processes
120	0.05	2008 A11-C04A	Surface treatment - painting, printing
106	0.09	2008 A08-C01	Crosslinkers, vulcanisers, accelerators and activators for addition polymers [general]
105	0.31	2009 S06-K01A	Full colour
105	0.11	2009 A08-S02	Solvents; swelling agents
94	0.01	2008 S06-C03	Printing, press control
93	0.02	2008 S06-C03A	Printing - control

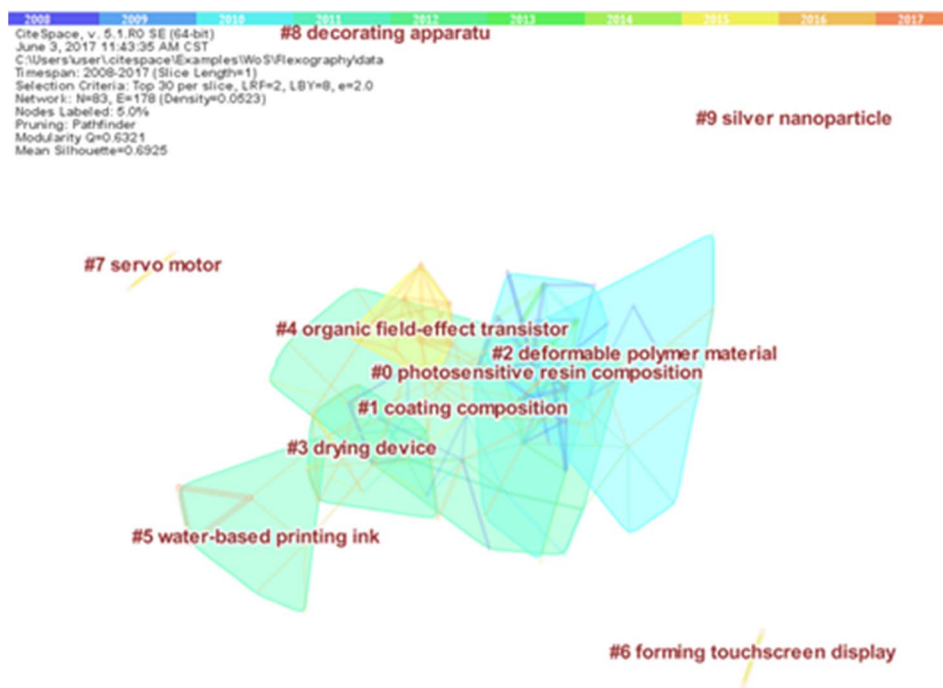


图2 柔印技术领域专利的德温特手工代码共现聚类图

Fig.2 Derwent's manual code co-occurrence clustering for flexographic printing technology

从图2上方的年代颜色可以看出,聚类的颜色越蓝说明这个领域出现的时间越早,该领域发展可能逐渐变得稳定。Cluster #4的颜色为黄色,体现出了新兴的发展领域。

从聚类信息表中可以看出,排名第1的聚类(Cluster #0)名称为感光性树脂组合物(Photosensitive resin composition)。这个聚类中包含20个德温特手工代码,且标记这些代码的专利平均发表年份在2009年。聚类的Silhouette值为0.845,表明标记了该聚类对应的专利有很高的一致性。各聚类信息见表2。

聚类包括光敏树脂化合物、涂层化合物、可变形高分子材料、烘干装置、有机场效应晶体管、水性印刷油墨、触屏显示器、伺服电动机、装饰设备、银纳米粒子等,从表2可以看出,各聚类的专利文献聚焦范围主要集中在印刷版材的制作、印刷油墨、印刷设备和柔性印刷在不同领域的功能性应用。其中,Cluster #0内手工代码标记最活跃的专利见表3。

从表3可以看出,SUGASAKIA在2010年的专利标记了Cluster #0内45%的手工代码,该篇专利对Cluster #0的手工代码的标记最为活跃。其次是BROWN DE,FOHRENKAMM EA,KITANI Y在2010年分别发表的3个专利,这3个专利均标记了聚类内40%的手工代码。

3.2 专利研究的热点分布

CiteSpace的词频探测技术(Citation Burst)可以将一定时间内被高度标记的手工代码探测出来。利用Citation Burst对相关专利数据进行探测,被探测出的

手工代码表示的对应领域,是柔印专利中在一定时间段内较为活跃的研究领域,即技术研发热点。需要注意的是该手工代码可能出现在更早的时间,只是随着时间的发展,在某一阶段因为成为被引用频率突然明显增多而被标记的领域。利用该功能探测出的Burst手工代码其强度由高到低排列,按强度排列的前20位手工代码中可以看出,G06-F03C(Radiation-sensitive composition containing polymer)的Burst强度最高为12.3747,其在2008—2009年被大量标记,表明在2008—2009年间,该领域是柔印研究的热门领域。

从另外一个角度,将这些探测到的Burst值用时间顺序进行排列,可以清晰地看到各个时间阶段柔性版印刷技术专利中最为活跃的研究领域。前20位手工代码及对应的名称见表4。

将这些探测到的Burst值用时间顺序进行排列,前20位手工代码对应名称见表5。

3.3 柔印领域专利研究前沿的演变路径

为了进一步了解柔印技术在2008—2017年间的新兴研究领域和研究前沿的变化,将每一年年中带红圈的节点(Burst)作为该年度技术前沿的代表,列入表1中,如果某一年度没有带红圈的Burst节点,将该年中被标记频次最多的节点作为其技术前沿的代表,形成了一条柔印专利前沿热点领域的演化路径。

将图1所示的柔性版印刷领域专利的德温特手工代码共现网络图谱转换为对应的timezone图谱,即将所有的节点定位在一个横轴为时间的二维坐标中,

根据首次被引用的时间，节点被设置在不同的时区中，所处位置随着时间轴一次向上，从左到右，自下向上的知识演进图就直观地展示出来了，见图 3。由于该图出现的代码均为首次出现的代码，可以通过每年新出现的代码来寻找出柔印技术的新兴研究领域发展轨迹。timezone 图谱各个年份德温特手工代码对

应的解释见表 6，可以看出从 2008 年开始，最先的研究焦点在于柔性版印刷的油墨和喷墨印刷研究领域，其次出现了对印版制版的研究，接下来几年又围绕着印刷设备的各个部分产生了新的研究领域变化，如控制系统、触屏、飞达和装帧部分。到了 2017 年，油墨的研究又出现了新的趋势。

表 2 各聚类信息
Tab.2 Clustering information

Cluster ID	Size	Silhouette	Mean (Year)	Top Terms (LSI)	Top Terms (Log-likelihood ratio)	Terms (mutual information)
0	20	0.845	2009	imaging; printing layer; top surface; imaging system;	photosensitive resin composition (5279.9, 1.0E-4); coating composition (4526.44, 1.0E-4); flexographic printing plate (4255.33, 1.0E-4);	having radically-polymerizable double bond (5.15); second exposed particle surface area (5.15); adjusting position (5.15);
1	17	0.794	2011	pigment; aqueous flexographic ink composition;	coating composition (4670.77, 1.0E-4); flexographic printing plate (3851.02, 1.0E-4); photosensitive resin composition (3268.14, 1.0E-4);	having radically-polymerizable double bond (3.29); second exposed particle surface area (3.29); adjusting position (3.29);
2	13	0.784	2009	flexible media; printing machine; optical displacement sensor;	deformable polymer material (1689.39, 1.0E-4); fabric article (1652.58, 1.0E-4); printing roller (1517.72, 1.0E-4);	having radically-polymerizable double bond (1.29); second exposed particle surface area (1.29); adjusting position (1.29);
3	11	0.775	2010	image; forming reproducible image; ejecting ink repellent;	drying device (2433.94, 1.0E-4); inkjet printer (1726.94, 1.0E-4); screen roller (1704.22, 1.0E-4);	having radically-polymerizable double bond (0.87); second exposed particle surface area (0.87); adjusting position (0.87);
4	9	0.864	2015	packaging paper; coating; seals; inner surface;	organic field-effect transistor (1092.15, 1.0E-4); comprising organic light-emitting diode (1092.15, 1.0E-4); organic thin-film transistor (1092.15, 1.0E-4);	inner surface (0.06); single process packaging (0.06); using heat (0.06);
5	7	0.863	2014	resin; modular structure; sealing label;	water-based printing ink (984.42, 1.0E-4); polymeric flexographic ink (753.21, 1.0E-4); resin emulsion (585.35, 1.0E-4);	silicon liner (0.04); laminating coated silicon liner (0.04); sensitive label (0.04);
6	2	1	2015	article; instrument; features;	forming touchscreen display (169.56, 1.0E-4); applying composition (169.56, 1.0E-4); containing photocurable acrylate (169.56, 1.0E-4);	flexographic printing plate (0.01); adjusting position (0.01); touch screen (0.01); performing vision-guided alignment (0.01);
7	2	1	2016	base layer; surface; heat radiator material;	servo motor (140.65, 1.0E-4); synchronous belt (140.65, 1.0E-4); printing roller shaft (140.65, 1.0E-4);	flexographic printing plate (0.01); photosensitive resin composition (0.01); original plate (0.01);
8	1	0	2008	decorating product; decorating apparatus; objects;	decorating apparatus (190.94, 1.0E-4); decorating product (190.94, 1.0E-4); transfective liquid crystal display device (136.27, 1.0E-4);	flexographic printing plate (0.01); photosensitive resin composition (0.01); original plate (0.01);
9	1	0	2014	stabilizer; copolymer; electrophoretic devices;	silver nanoparticle (157.78, 1.0E-4); screen ink (129.06, 1.0E-4); aminomethylsilane viscosifier (129.06, 1.0E-4);	flexographic printing plate (0.01); photosensitive resin composition (0.01); original plate (0.01);

表3 对 Cluster #0 内手工代码标记最活跃的专利
Tab.3 List of the most active patents for manual code tagged in Cluster #0

Coverage	Author and Year	Patent
0.45	SUGASAKI A (2010)	composition useful for laser engraving comprises compound having hydrolyzable silyl/silanol group and binder polymer having functional group capable of forming crosslinked structure by reacting with hydrolyzable silyl/silanol group.
0.4	BROWN DE (2010)	making a relief image, comprises forming mask image by forming exposed and non-exposed regions in imaged film, transferring the mask image to radiation-sensitive element, and exposing the radiation-sensitive element to curing radiation.
0.4	FOHRENKAMM EA (2010)	flexographic relief printing plate processing solution used for photopolymer compositions, comprises diisopropylbenzene, and organic co-solvent(s), at least one of which is an aliphatic dibasic acid ester.
0.4	KITANI Y (2010)	photosensitive resin composition for flexographic printing plate, contains hydrophilic polymer and hydrophobic polymer containing polybutadiene, acrylonitrile-butadiene copolymer and methyl methacrylate copolymer.
0.35	ARAKI Y (2010)	photosensitive resin composition for printing plate, contains hydrophilic copolymer formed by emulsion polymerization using reactive emulsifying agent, thermoplastic elastomer, photopolymerizable unsaturated monomer and photoinitiator.
0.35	BEREZIN O (2010)	uv photo-mask producing process, involves performing direct printing process on photo-polymeric surface to affect immobilization of ink droplets as ink dots to form pattern on top of surface.
0.35	INOUE D (2010)	photosensitive resin composition used for printing original plate for flexographic printing plate, comprises water dispersion latex, rubber, surfactant, photopolymerizable monomer and photoinitiator.
0.35	KAWASHIMA T (2010)	making relief printing plate useful for printing in e.g. flexographic printer involves laser-engraving relief printing plate precursor formed of thermally crosslinkable resin composition.
0.35	MATSUBARA T (2010)	block copolymer composition for flexographic plate, contains aromatic vinyl conjugated diene-aromatic vinyl block copolymers having preset content of aromatic vinyl monomer unit.
0.35	SCHADEBRODT J (2010)	method for manufacturing flexographic printing plate, involves exposing photopolymerizable relief layer to actinic light with high radiation intensity in initial stage and low radiation intensity in successive stage.
0.3	HANNUM R (2010)	preparation of composite printing form used for e.g. relief printing, comprises securing element to carrier, imagewise exposing infrared sensitive layer, overall exposing element to actinic radiation through mask, and treating element.
0.3	OSHITA S JP (2010)	curable resin composition for flexographic printing plate material, comprises acrylic type block copolymer having weight average molecular weight in preset range, polymerization initiator and polymerizable monomer.

表4 按强度排列的前20位手工代码对应名称
Tab.4 MC translation of top 20 manual codes arranged by intensity

MC	Burst	Begin	End	MC Translation
G06-F03C	12.3747	2008	2009	Radiation-sensitive composition containing polymer
A11-C01C	11.8995	2012	2013	Other bonding to make specific goods [exc. heat sealing, welding]
A12-W07C	10.5939	2008	2009	Other printing plates produced (electro)photographically [exc. lithographic]
S06-K02	8.9554	2015	2017	Sheet feeding
G02-A02C	8.9554	2015	2017	Paints, varnishes, lacquers based on acrylics [general]
S06-C02A	8.8139	2008	2009	Printing plate production
S06-K99C	8.81	2011	2012	Printer
S06-K07A	8.5762	2012	2017	General Control systems
S06-E04B1	7.8969	2015	2017	Composition of liquid developer
G06-G18	7.3503	2008	2010	Image formation by exposure to ionising radiation, light etc.
S06-G04	6.1682	2014	2017	Inkjet ink
A08-S02	5.9824	2015	2017	Solvents; swelling agents
G06-G17	5.8367	2008	2010	Development of photosensitive resin systems
A12-W07F2	5.6231	2012	2013	Printing substrates
A12-W07D1	4.5471	2015	2017	Inkjet inks
S06-E03A2	4.4753	2014	2017	Light source type - LED
A04-H00H	4.4753	2014	2017	General addition type resin
G06-F03D	4.148	2008	2010	Radiation-sensitive composition containing polymeric additives
A12-W07A	3.4975	2010	2011	Printing plates produced non-photographically
A08-D01	2.4621	2012	2013	Crosslinkers and accelerators for other polymers [exc. addition and ethylenically unsatd. polymers] [general]

表 5 按时间顺序排列的前 20 位手工代码对应名称
Tab.5 MC translation of the first 20 manual codes in chronological order

MC	Burst	Begin	End	MC Translation
A12-W07C	10.5939	2008	2009	Other printing plates produced (electro)photographically [exc. lithographic]
G06-F03C	12.3747	2008	2009	Radiation-sensitive composition containing polymer
G06-F03D	4.148	2008	2010	Radiation-sensitive composition containing polymeric additives
S06-C02A	8.8139	2008	2009	Printing plate production
G06-G17	5.8367	2008	2010	Development of photosensitive resin systems
G06-G18	7.3503	2008	2010	Image formation by exposure to ionising radiation, light etc.
A12-W07A	3.4975	2010	2011	Printing plates produced non-photographically
S06-K99C	8.81	2011	2012	Printer
A12-W07F2	5.6231	2012	2013	Printing substrates
A08-D01	2.4621	2012	2013	Crosslinkers and accelerators for other polymers [exc. addition and ethylenically unsatd. polymers] [general]
S06-K07A	8.5762	2012	2017	General Control systems
A11-C01C	11.8995	2012	2013	Other bonding to make specific goods [exc. heat sealing, welding]
S06-E03A2	4.4753	2014	2017	Light source type - LED
A04-H00H	4.4753	2014	2017	General addition type resin
S06-G04	6.1682	2014	2017	Inkjet ink
S06-E04B1	7.8969	2015	2017	Composition of liquid developer
S06-K02	8.9554	2015	2017	Sheet feeding
G02-A02C	8.9554	2015	2017	Paints, varnishes, lacquers based on acrylics [general]
A08-S02	5.9824	2015	2017	Solvents; swelling agents
A12-W07D1	4.5471	2015	2017	Inkjet inks

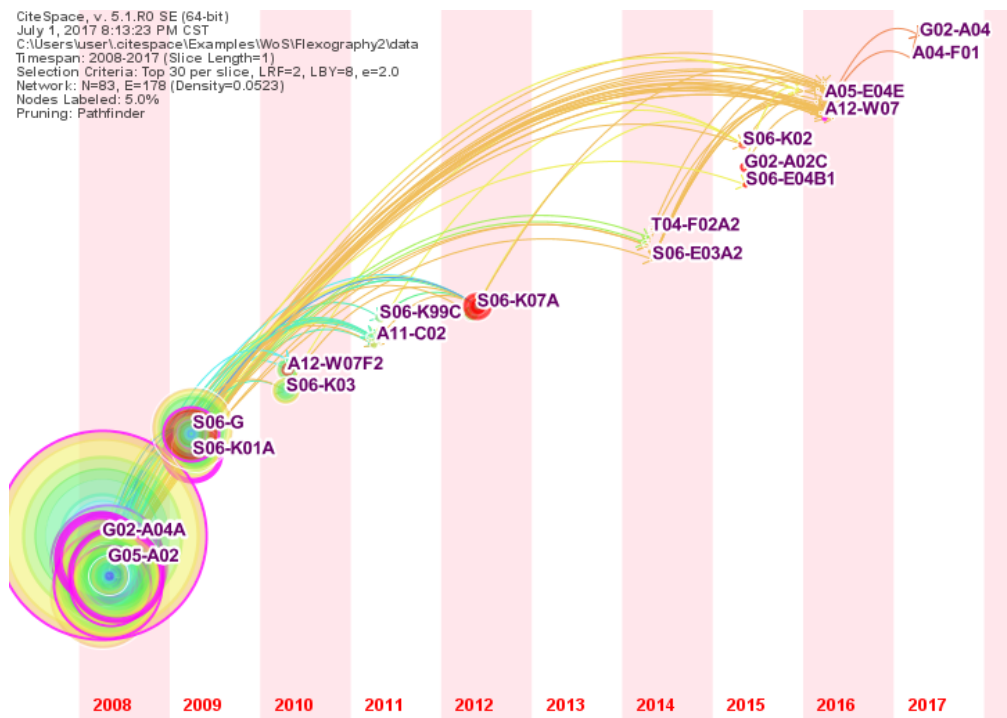


图 3 柔印技术领域发展前沿的 timezone 图谱

Fig.3 Timezone map of frontier development in flexographic printing technology

表 6 timezone 对应的德温特手工代码
Tab.6 Derwent's manual codes for timezone

年份	德温特手工代码	频次	Burst 值	技术前沿领域
2008	G02-A04A	379		Printing and writing inks
2009	S06-G	162		Ink-Jet Image Production
2010	A12-W07F2	48	5.6231	Printing substrates
2011	S06-K99C	24	8.81	Printer
2012	S06-K07A	58	8.5762	General Control systems
2013				
2014	T04-F02A2	13		Touchscreen
2015	S06-K02	17	8.9554	Sheet feeding
2016	A12-W07	5		Printing; book binding
2017	G02-A04	2		Printing and writing inks; pencil leads, crayons [general]

3.4 柔印领域专利权人分析

在 CiteSpace 软件中以 Institution 为节点，可以得到柔印领域内各专利的专利权人知识图谱，方便我们更加清晰的了解各个公司在柔印领域内的专利申请情况。CiteSpace 相关参数设置：年份选择为 2008

—2017 年，时间切片为 1 年；术语来源为 Title, Abstract, Author Keywords(DE)；节点类型为 Institution(C1)；修剪算法为 Pathfinder-Pruning sliced networks；设定标准为 top50。运行 CiteSpace 软件，最终得到一个节点数为 98，网络密度 $E=8$ (Density=0.0017)的专利权人共现网络图谱，见图 4。



图 4 柔性版印刷领域专利的专利权人共现网络图谱
Fig.4 Patented owner's co-map of patents in flexographic printing

从图 4 可以看出，在 2008—2017 年间，以 FUJI FILM CORP (FUJF-C)为专利权人的专利最多，达到了 27 项。其专利首次出现时间为 2014 年，并在 2014—2016 年处于专利申请的爆发时期，Burst 值高达 10.65。除此之外，FUJI FILM CORP (FUJF-C)与其兄

弟公司共同申请的专利还有 30 项，以 FUJI FILM CO LTD (FUJF-C)为专利权人的专利申请也有 16 项。说明富士胶片集团在柔印领域有很强的研究实力。以 FLINT GROUP GERMANY GMBH (FLIN-Non-standard)为专利权人的专利从 2010 年开始出现，总

计10项。

4 结语

结合文中研究的相关数据可视化分析,关于柔性版印刷的专利研究主要集中在柔印版制作、柔印油墨、柔印设备的改善以及利用柔印印刷电子电路的研究领域,其中柔印油墨和印版制作的研究开始较早,也是当今的研究热门领域。后期针对印刷设备各部分的研究开始增多,对印刷工艺持续提升提供了技术支持。

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