Intellectual property analysis of holographic materials business

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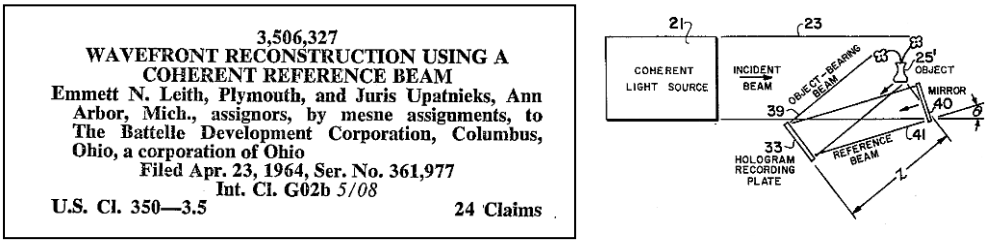
ABSTRACT

The paper presents an overview of intellectual property in the field of holographic photosensitive materials and highlights the possibilities offered by patent searching and analysis. Thousands of patent documents relevant to holographic materials have been uncovered by the study. The search was performed in the following databases: U.S. Patent Office, European Patent Office, and Japanese Patent Office for the time frame of 1971 through November 2005. The patent analysis has unveiled trends in patent temporal distribution, leading IP portfolios, companies' competition within the holographic materials market and other interesting insights.

Keywords: hologram, patent, intellectual property, material, media, recording, holography

1. INTRODUCTION

High-resolution photosensitive material is the most essential component of the hologram recording. For a long time it has been a crucial element determining the final product properties. As holography traces its origin to photography, the first materials used for hologram recording had been photographic emulsions; as exemplified by the original, Leith and Upatnieks' patent 3506327 filed April 23, 1964 and entitled "Wavefront reconstruction using a coherent reference beam".



3,506,327
WAVEFRONT RECONSTRUCTION USING A COHERENT REFERENCE BEAM
Emmett N. Leith, Plymouth, and Juris Upatnieks, Ann Arbor, Mich., assignors, by mesne assignments, to The Battelle Development Corporation, Columbus, Ohio, a corporation of Ohio
Filed Apr. 23, 1964, Ser. No. 361,977
Int. Cl. G02b 5/08
U.S. Cl. 350—3.5 24 Claims

Fig. 1 Pioneer patent US3506327 by Leith and Upatnieks disclosing of-axis beam recording on photographic plate.

The development of materials has progressed along with advances in recording techniques. The obvious practical advantage of white light reconstruction offered by the holograms recorded in opposite beams (Denisyuk's scheme [1]) could be realized only with material resolution of an order of thousands lines per millimeter. Further progress in holographic media improved their photo sensitivity, simplified material processing and provided new features, such as multiple recording, polychromatism, and others. Table 1 represents a summary of the principal holographic materials and their characteristics [2].

Note that Table 1 does not include materials used in the mass replication of an existing hologram by embossing techniques. Detailed analysis of the embossed hologram business could be found in our paper [3].

Intelectual property protection in holography have been an integral part of business since the beginning of 1970s when the first holographic material patents have appeared.. In the course of the last 30+ years thousands of patents have been issued creating valuable assets for their owners. Besides protecting their owners products, these patents are valuable possessions that can be licensed, sold, leased, used as a collateral for business financing. The assessment of the patent value is a multi-step process, a key element of which is retrieval of relevant prior art and its subsequent comparative

Material	Reusable	Processing	Type of hologram	Max. efficiency	Required exposure [mJ/cm^2]	Resolution limit [mm^{-1}]
Photographic emulsions	No	Wet	Amplitude Phase (bleached)	6% 60%	0.001–0.1	1'000–10'000
Dichromated gelatin	No	Wet	Phase	100%	10	10'000
Photoresist	No	Wet	Phase	33%	10	3'000
Photothermoplastics	Yes	Charge and heat	Phase	33%	0.01	500–1'200
Photopolymers	No	Post exposure	Phase	100%	1–1'000	2'000–5'000
Photochromics	Yes	None	Amplitude	2%	10–100	>5'000
Photorefractives	Yes	None	Phase	100%	0.1–50'000	2'000–10'000

Table 1. General properties of recording materials for holography [2].

analysis. In this paper we discuss the world of holographic materials IP without pretending to encompass the whole patent portfolio. We reveal techniques and approaches typically used in patent evaluation and provide examples from among the holographic materials patents.

2. PATENT DATABASES USED

This paper provides a brief overview of worldwide intellectual property centered on holographic materials. These results were obtained as a result of an analysis of thousands of patent documents granted or published by United States Patent and Trademark Office (USPTO), European Patent Office (EPO), Japanese Patent Office (JPO), and World Intellectual Property Organization (WIPO) from January 1971 to November 2005. The analysts relied on several patent search engines to prepare the results and validate these findings.

The 'EAST' database, located in the United States Patent Office public search room, is a fast and versatile research tool. The system provides fast, user-friendly access to U.S., European and Japanese patent collections. This database was extensively used in preparing this paper.

EAST has a vast collection of U.S. patents for the period of 1971-2005. However the results provided by EAST with regards to European and Japanese patent were limited. Therefore, additional sources were used.

U.S. patent documents can be alternatively accessed via USPTO web site (www.uspto.gov) and through several proprietary professional patent search engines. The USPTO web site is free of charge and a useful source of patent information. It allows search by keywords, publication/filing dates, inventor's name, assignee and many other kinds of search. It is not as easy to use or as complete in its coverage and search capabilities as the databases provided by Micropatent PatentWeb, Derwent, Delphion, Univentio, or Questel-Orbit.

We have also used a database of European patents, known as Esp@cenet, available at http://ep.espacenet.com. Unfortunately this database has a search engine that allows to searched for keywords in the abstract and title of references, but not in the full text. Lack of this essential feature severely reduces the probability of discovery of all relevant documents. However our experience shows that it is helpful to use this database, especially to find Chinese patent documents that are rarely found in other databases. This database is also free of charge.

Most countries have national patent databases. Often the knowledge of the country's language is required in order to efficiently use the database, although most countries have patent abstracts available in English. All national patent databases are free of charge for the users. As a national database example this search included analysis of Japanese Patent office documents on holographic materials. Japanese patents can be found at http://www.jpo.go.jp/. The website for keyword searching within the Japanese database is at http://www19.ipdl.ncipi.go.jp/PA1/cgi-bin/PA1INIT?1133843051625

U.S. Patents/Published Applications
USPTO EAST System – US Granted Patents: Full-text 1971-present, OCR text 1920-1970, Images 1790-present; US Pre-Grant Published Applications: Full-text and Images 3/15/01-present.

Foreign Patents/Published Applications

USPTO EAST System – Patent documents available (as of 1/6/05):
Swiss: CH 594283A (1/13/78) – 694191A5 (8/31/04)
German: DE3140049A1 (6/03/92) – 102004012962A1 (9/02/04)
European: 2A1 (2/20/78) – 1453371A2 (9/01/04)
French: FR2529498A1 (1/06/92) – 2851879A1 (9/03/04)
British: GB2000021A (1/04/79) – 2398983A (9/01/04)
WIPO: WO7900023A1 (1/25/79) – 2004073370A1 (8/26/04)
Japan: JP51111002A (10/01/76) – JP2003245000A (7/29/04)

DialogPro:
Japanese (JAPIO) Abstracts: October 1976 to present
European Full-text: December 1978 to present
WIPO/PCT Full-text: 1978+
French Patents: All patents – 1966-2001, Medicaments – 1961-1978
Chinese Abstracts: April 1985 to present

MicroPatent – PatentWeb:
Full-text of US, EP (EP-A, EP-B), PCT, Great Britain, and German (DE-C, DE-B, DE-A, DE-T, DE-U) patent documents and front page of Japanese (JP) documents. US, EP and DE are covered at first publication and when granted. US data is from 1836, EP from 1978, PCT from 1978, Great Britain from 1979, German from 1989 and French from 1981.

Derwent Patent Citation Index (DPCI):
European (EP) and WO citations – 1978 +
US citations – 1973 +
Germany (DE) – April 28, 1994 +
Japan (JP) – April 5, 1994 +
Great Britain (GB) – May 18, 1994 +

Delphion:
European Granted (EP-B) – Full Text: January 1991 to present; Front Pages & Images: January 1980 to present
European Applications (EP-A) – Full Text: January 1987 to present; Front Pages & Images: January 1979 to present
German – Full Text: January 1987 to present; Biblio & First Claim: January 1968 to present
WIPO (PCT): October 1978 to present
Japanese front page and images (JP): October 1976 to present

*Derwent World Patent Index (DWPI) Abstracts: **

ARGENTINA	1975 only	LUXEMBOURG	1984 (Week 43) onwards
AUSTRALIA	1963 - 1969, 1983 onwards	MEXICO	1998 onwards (pending)
AUSTRIA	1975 (Week 15) onwards	NETHERLANDS	1963 onwards
BELGIUM	1963 onwards	NEW ZEALAND	1993 onwards
BRAZIL	1976 onwards	NORWAY	1974 (Week 48) onwards
CANADA	1963 onwards	PCT (WORLD) PATENTS	1978 (Week 49) onwards
CHINA	1987 onwards	PHILIPPINES	1995 (Week 11) onwards
CZECHOSLOVAKIA	1975 (Week 20) - 1994	PORTUGAL	1974 (Week 52) onwards
CZECH REPUBLIC	1994 (Week 17) onwards	ROMANIA	1975 (Week 32) onwards
DENMARK	1974 (Week 45) onwards	RUSSIAN FEDER.	1994 (Week 6) onwards
EUROPEAN PATENTS	1978 (Week 49) onwards	SINGAPORE	1995 (Week 13) onwards
FINLAND	1974 (Week 45) onwards	SLOVAKIA	1994 (Week 17) onwards
FRANCE	1963 onwards	SOUTH AFRICA	1963 onwards
GERMANY	1963 onwards	SOVIET UNION	1963 - 1994
GERMANY [Utility]	[1996 (Week 26) onwards]	SPAIN	1983 (Week 34) onwards
HUNGARY	1975 (Week 26) onwards	SWEDEN	1974 onwards
IRELAND	1963-1969, 1995 (Week 21) onwards	SWITZERLAND	1963 onwards
ISRAEL	1975 (Week 15) onwards	TAIWAN	1993 (Week 24) onwards
ITALY	1966 - 1969 Sect. A, 1978 onwards	UNITED KINGDOM	1963 onwards
JAPAN	1963 onwards	UNITED STATES	1963 onwards
REPUBLIC OF KOREA (SOUTH KOREA)	1986 (Week 40) onwards		

* Not all kind codes begin on the dates show

Table. 2. Coverage of commonly accessed sources of patent documents.

Landon IP uses the databases listed in Table 2 on a regular basis when conducting a professional patent search. Often, Landon IP patent analysts will conduct the search in several of these databases in order to retrieve the best possible results. Professional patent search engines require the purchase of either a subscription or a one-day pass.

When performing a search, the analyst should know that many databases have limited data coverage: the earliest date of publications and the gaps in coverage need to be checked before starting the search. Fortunately, photonics and optoelectronics are fast changing fields of science, and for majority of projects there is no need to search deep into the past.

Table 2 represents the coverage for the commonly used patent databases. Patents since 1970s are available for majority of the countries.

3. SEARCH STRATEGY

The keyword search using the following queries has been performed:

"holographic and (media or material)"
"hologra* and (media and material) and (photosensitiv*3 or lightsensitiv*3 or light-sensitiv*3)"

The asterisk means that all words having "hologra" will be considered, for example, hologram, holography, holographic. A combination of the asterisk and a number, for example *3, means that any three letter can follow the previous part of word.

It should be pointed out that alternatively or additionally the search can be performed seeking patent documents in relevant subclasses. Is it well known that all patent documents are sorted by technological area classes and subclasses. Table 3 shows the principal subclasses relevant to holographic materials. This table does not include US subclasses that

Class	Subclass	Description
US classification		
359		Optical: systems and elements
	3	Holographic system or element: Having particular recording medium
	4	Holographic system or element: Having particular recording medium: Recyclable
430		Radiation imagery chemistry: process, composition, or product thereof
	1	HOLOGRAPHIC PROCESS, COMPOSITION, OR PRODUCT
	2	HOLOGRAPHIC PROCESS, COMPOSITION, OR PRODUCT: Composition or product or process of making the same
	401	POST IMAGING PROCESSING
	494	INCLUDING EXPOSURE STEP OR SPECIFIED PRE-EXPOSURE STEP PERFECTING EXPOSURE
PCT (International) classification		
G03H		Holographic Processes and apparatus
G03H1/02 (or G03H00102)		Details (record carriers in general);
G03H1/04 (or G03H00102)		Processes or apparatus for producing holograms;
G03H1/26 (or G03H00126):		Processes or apparatus specially adapted to produce multiple holograms or to obtain images from them, e.g. multicolour technique
Japanese classification		
theme 2K008		Physics
	G03H 1/00 - 5/00	Holography

Table 3. Principal patent subclasses relevant to holographic materials.

that specifically addressing particular chemical substances or part of the processing (for example 430/219 “Silver halide developing retarder or antifoggant”) . These subclasses can be founded by interested reader at the USPTO website http://www.uspto.gov/go/classification/.

4. SEARCH RESULTS

In many prior art searches it is possible to create a keyword string that allows selecting all relevant patents and excluding the majority of irrelevant ones. Unfortunately in the case of holographic materials it is impossible to generate such ideal string. There are two main reasons for that: the diversity of materials for holography and the fact that materials are necessary element of any hologram recording; and it is hard to sort out patents specifically describing new materials from the patents disclosing new holographic technique, devices and methods that use standard or known materials. For example, Micropatent database unveils 24830 patent documents that are related to string “holographic and (material or medium)”. A careful manual selection of relevant patents is the only options for such complicated cases.

4.1 Major tendencies observed in holographic materials IP.

Typical diagram of patent distribution for holographic material IP is shown in Fig. 2 and Fig. 4. Fig. 2 shows temporal distribution of patent documents. A manual selection of relevant patents has been carried out from patents sorted by keyword string “holographic and (material or medium) and photosensitivity” from Micropatent worldwide database for years 1971-2005. The patent database has been reduced to one patent per family. The average number of family members turned to be about 2.

In general the observed temporal distribution of patent documents is quite typical for any high tech category in optics and optoelectronics. Some rise of interest in innovative materials that can be observed in late 1970s is specific for this

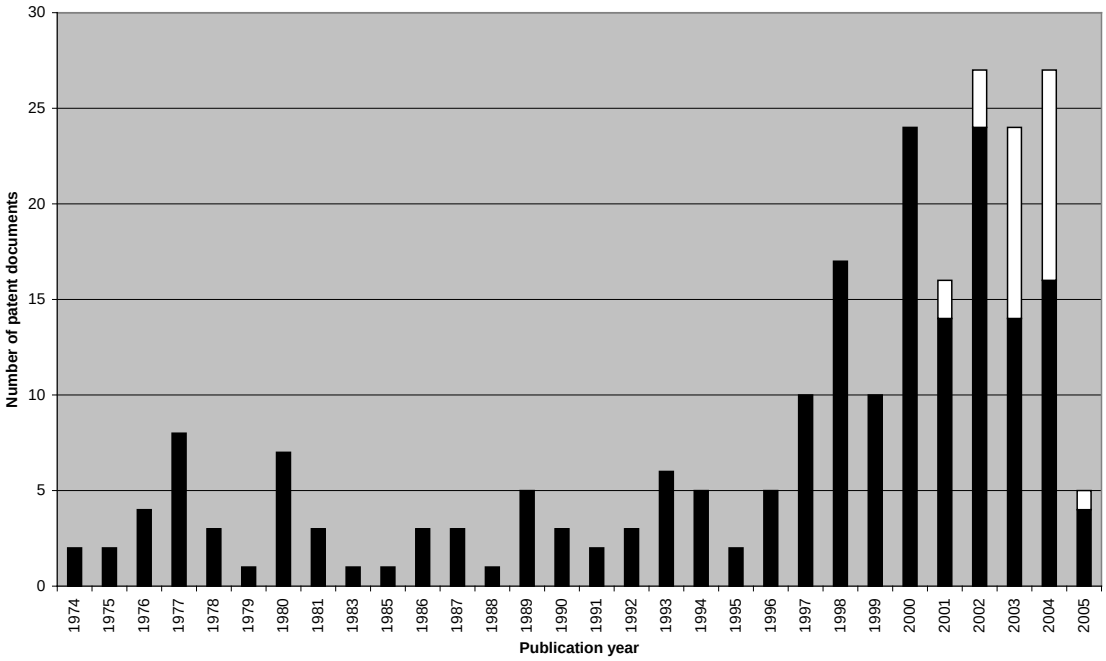
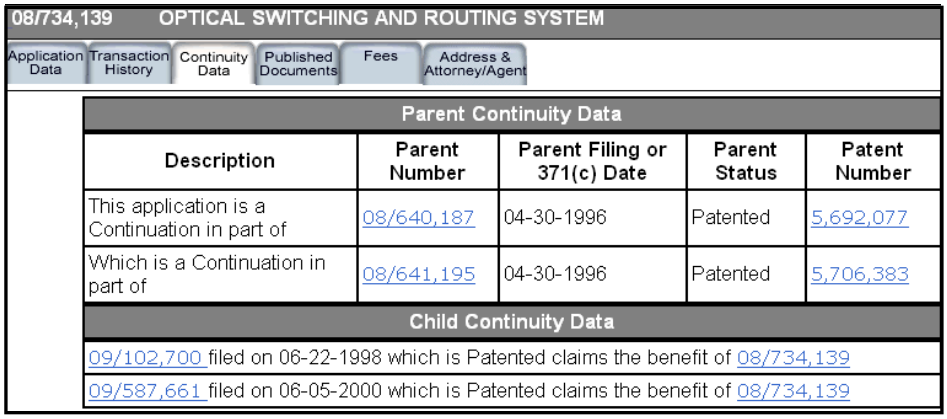


Fig. 2 Temporal distribution of patents (black) and patent applications (white) in category “Holographic photosensitive materials”.

category. It is probably associated with overall interest to holography at that time, when scientist predicted a bright future for holographic technologies and their penetration into all aspects of our everyday life.

The information on patent family for US patents can be found on the website
http://portal.uspto.gov/external/portal/pair
using “Continuity data” folder. Fig. 3 shows an example of family information for the US patent application #08/734,139. As one can observe this patent has two parents and two children.



08/734,139 OPTICAL SWITCHING AND ROUTING SYSTEM

Application Data | Transaction History | Continuity Data | Published Documents | Fees | Address & Attorney/Agent

Parent Continuity Data

Description	Parent Number	Parent Filing or 371(c) Date	Parent Status	Patent Number
This application is a Continuation in part of	08/640,187	04-30-1996	Patented	5,692,077
Which is a Continuation in part of	08/641,195	04-30-1996	Patented	5,706,383

Child Continuity Data

09/102,700 filed on 06-22-1998 which is Patented claims the benefit of 08/734,139

09/587,661 filed on 06-05-2000 which is Patented claims the benefit of 08/734,139

Fig.3 An example of patent family.

Fig. 4 shows assignees for patent documents on holographic materials. The results of this analysis was kind of surprising for us. The first thing one can see from this figure is enormous amount of patents owned by Ciba company. We have checked the total number of patent documents owned by Ciba Specialty Chemicals Holding, and it appeared to be 200 patents. Keyword string “holographic and (medium or material)” has been used for this selection. Such string makes sense in this case because Ciba is a chemical company and does not have patents on holographic devices or methods.

It should be pointed out that Ciba’s patent do not describe novel holographic materials. Their patents address particular chemical components that can find various applications. See for example abstract of Ciba’s patent US 20050191567 by Kunimoto, filed Sept.1, 2005: “Compounds of the formulae I, II, III, IV and V 1 wherein R.sub.1 i.a. is C.sub.4-C.sub.9cycloalkanoyl, C.sub.1-C.sub.12alkanoyl, C.sub.4-C.sub.6alkenoyl, or benzoyl; R.sub.2 is for example phenyl, C.sub.1-C.sub.20alkyl, C.sub.3-C.sub.8cycloalkyl, C.sub.2-C.sub.20alkanoy- l, or benzoyl; Ar.sub.1 is R.sub.4S-phenyl or NR.sub.5R.sub.6-phenyl, each of which optionally is substituted; or Ar.sub.1 i.a. is 2 optionally substituted; or Ar.sub.1 is naphthyl or anthracyl each of which is unsubstituted or substituted; or Ar.sub.1 is benzoyl, naphthalenecarbonyl, phenanthrenecarbonyl, anthracenecarbonyl or pyrenecarbonyl, each of which is unsubstituted or substituted, or Ar.sub.1 is 3,4,5-trimethoxyphenyl, phenoxyphenyl or biphenyl; Ar.sub.2 i.a. is 3 optionally substituted, or naphthyl or anthracyl, each of which is unsubstituted or substituted, x is 2 or 3; M.sub.1 when x is 2, for example is phenylene, naphthalene, anthracylene, each of which optionally is substituted; M.sub.1, when x is 3, is a trivalent radical; M.sub.2 for example is 4 M.sub.3 is for example C.sub.1-C.sub.12alkylene, cyclohexylene, or phenylene; n is 1-20; R.sub.3 is for example hydrogen or C.sub.1-C.sub.12alkyl; R.sub.3' i.a. is C.sub.1-C.sub.12alkyl; substituted or --O-interrupted C.sub.2-C.sub.6alkyl; R.sub.4 is for example hydrogen, or C.sub.1-C.sub.12alkyl; and R.sub.5 and R.sub.6 independently of each other i.a. are hydrogen, C.sub.1-C.sub.12alkyl, or phenyl; are suitable as photoinitiators in particular in resist applications.”

This kind of photoinitiator described in above paragraph can be used in particular for holographic recording material. See Claim 14 of the mentioned above patent: “A process according to claim 13 for producing pigmented and non-pigmented paints and varnishes, powder coatings, printing inks, printing plates, adhesives, dental compositions, photoresists for electronics like electroplating resist, etch resist, both liquid and dry films, solder resist, as resists to manufacture color filters for a variety of display applications or to generate structures in the manufacturing processes of

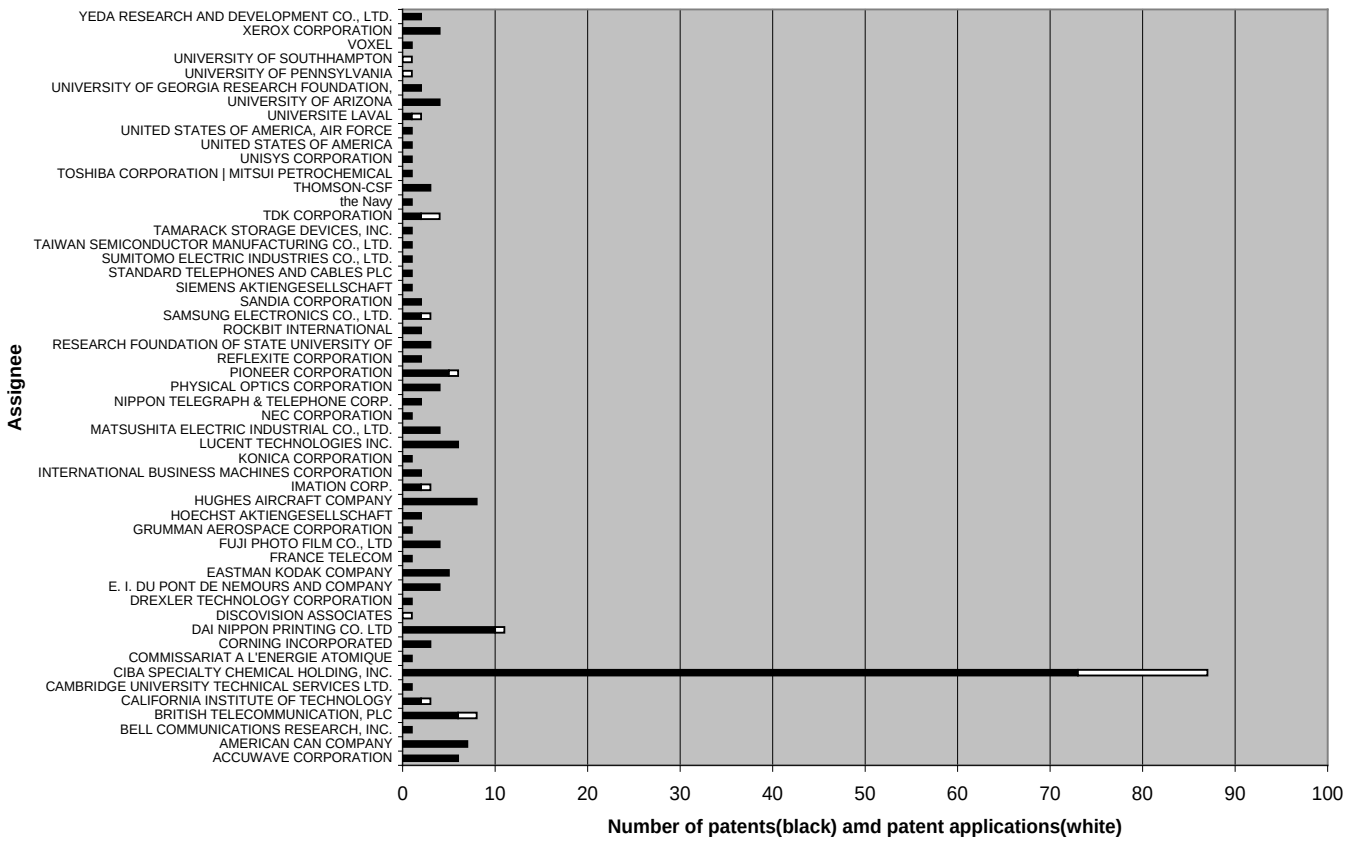


Fig.4 Assignee for patent documents on holographic materials and number of patents they own
(Micropatent database, years 1971-2005, keyword query "holographic and (material or medium) and photosensitivity")

plasma-display panels, electroluminescence displays and LCD, composite compositions, resists, including photoresists, color filter materials, compositions for encapsulating electrical and electronic components, for producing magnetic recording materials, micromechanical parts, waveguides, optical switches, plating masks, etch masks, colour proofing systems, glass fibre cable coatings, screen printing stencils, for producing three-dimensional objects by means of microlithography, plating, stereolithography, for producing image recording materials, ***for producing holographic recordings***, microelectronic circuits, decolorizing materials for image recording materials using microcapsules".

The detailed analysis of Ciba's patents on holographic materials would be very useful, however it is out of the scope of this paper; and we leave it for inquisitive reader to perform himself. Here we would like to make emphasis on dominating position of this company in holographic media IP.

The analysis of top assignees in the field of holographic materials (Fig. 4) shows a large number of Japanese companies in holographic material business. We have performed a detailed analysis of Japanese patents on holographic materials aiming two goals. First goal is to unveil the trends and achievements in Japanese IP on holographic materials. And the second goal is to provide information on general approach to national patents evaluation that can be used by a reader to perform the analysis himself for any other country (national patent database).

4.2 Japanese patent portfolio on holographic materials

We used a following query to select patent documents in this case:
"Holographic and (material or medium)".

The search of Japanese IP in the field of holographic materials was performed in Japanese Patent Office database, Derwent (Delphion) database and Micropatent database. Table 4 shows the number of patents that was unveiled in these databases. The results were combined and relevant patents were manually selected.

Database	Number of patent documents
Japanese patent office	46
Derwent (Delphion)	392
Micropatent	386

Table 4. Number of selected Japanese patents in different databases.

Fig. 5 represents the assignees of the Japanese patent documents on holographic materials and the number of patents they own. It is easy to observe that the total number of patent applications (white) is larger than the number of granted patents (black). This demonstrates current interest to holographic media. There are four leaders in this technical category: TDK, Fuji, Sony and Pioneer. It is interesting that almost all of their patent documents are recently filed patent applications. The analysis of the patents content showed that the majority of these documents describeinnovative holographic media for data storage. Such patent distribution allows assuming special programs and funding allocated for this project. We performed a quick business analysis that confirmed this assumption. For example, The Register News reported in November 24th, 2005 about Japan's company Optware that have secured $14M funding from four companies, one of which was Toshiba for a DVD-sized holographic disc that holds more than 1TB of data with a throughput of 1Gbps [4]. Another reference that is worth to mention here is the report of US Department of commerce on Japan's achievement in information technology [5]. The article states Japan's direction to promote information-centered, knowledge-intensive industries. Japan has implemented this goal through a set of National programs. Industrial strategies have been coordinated, and Ministry of International Trade and Industry introduced a series of multi-year plans devoted to achieving excellence in information technology. The article affirms that Japan is ahead of United States in optical storage technologies.

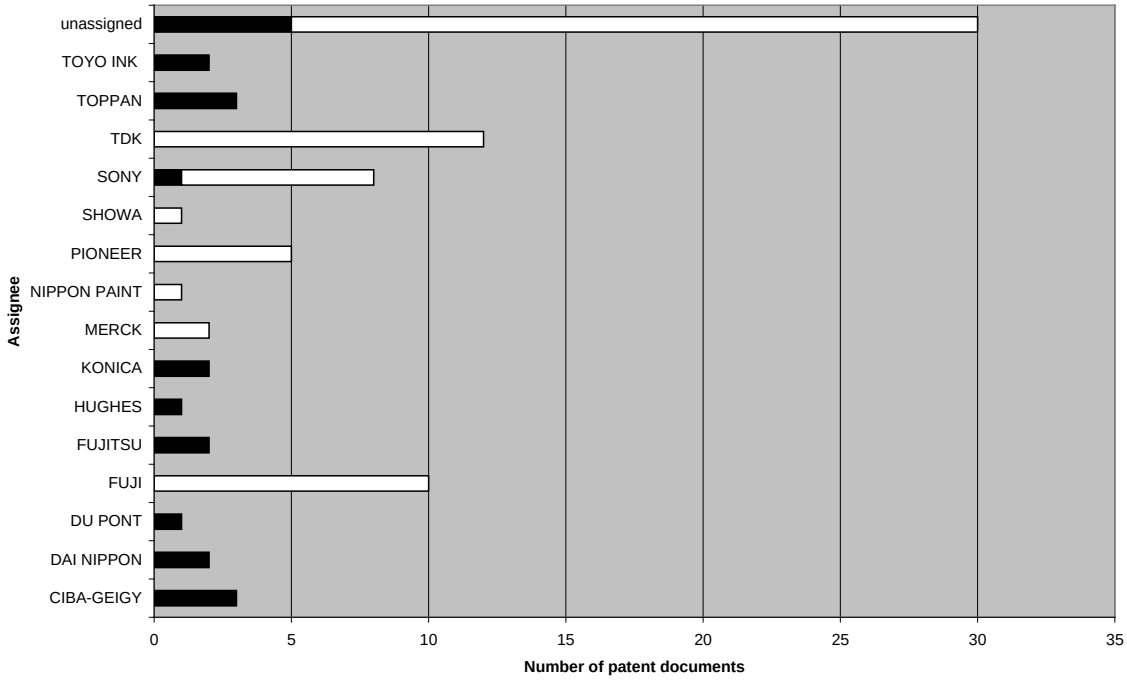


Fig. 5 Assignees of Japanese patents on holographic materials and the number of patents (black) and patent applications (white) they own.

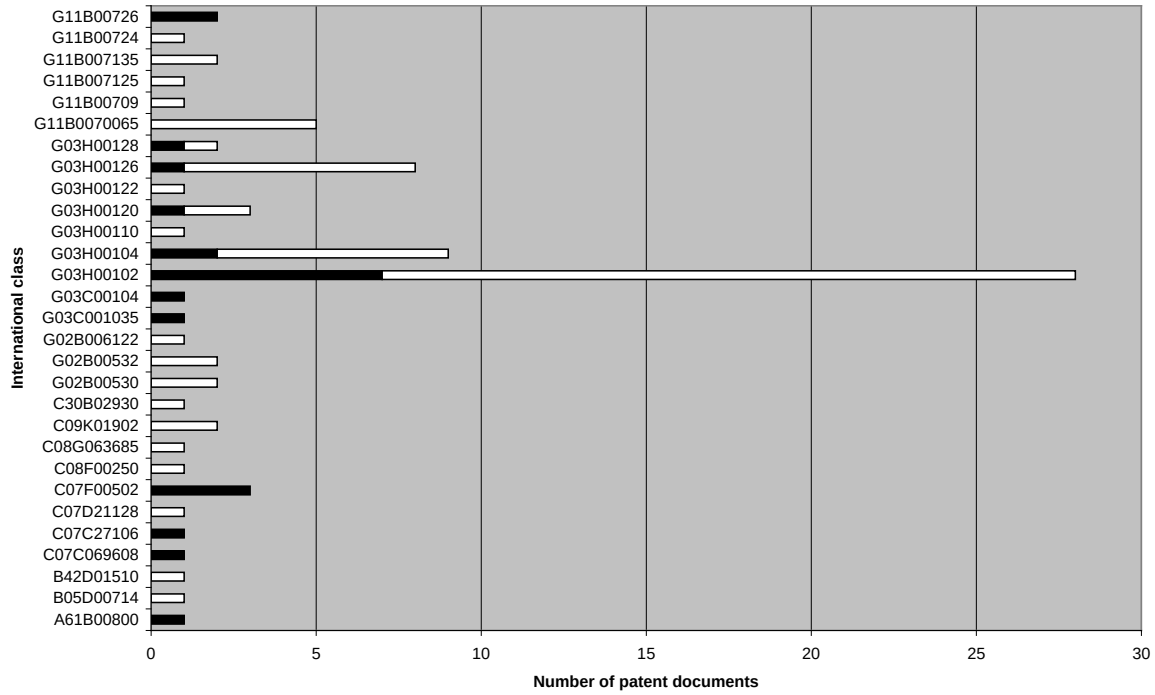


Fig. 6 Japanese patents distribution over International (PCT) subclasses.

We analyzed the distribution of Japanese patent documents over subclasses. The majority of patent falls into four main subclasses: G03H00102, G03H00104, G03H00126 and G11B0070065 (Fig.6). Three of these subclasses are related to holographic materials (see Table 3) and one of them, G11B0070065, is on data storage.

Fig. 6 clearly demonstrates one of the rules of prior art searching. When performing prior art search it is important to limit its scope to a few relevant subclasses. Usually at least 90% of important patents will be found within main subclasses.

If you read the description of subclasses, you'll notice how close sometimes their specifications are. One can only guess why the patent is assigned to this or that subclass. Patent assignment to one of the less crowded patent subclass may accelerate its prosecution.

4.3 Detailed analysis of a particular holographic material.

We have conducted detailed analysis of the patent portfolio relevant to a particular holographic medium. In this endeavor we sought to achieve two goals. First, we wanted to demonstrate wide range the capabilities of detailed patent analysis, so any reader can perform the similar one in the field of his interest. Second we wanted to study a novel technological area, switchable holographic materials. In our opinion these materials are very promising in application for tomorrow's displays. Keyword query
"Switchable and holographic and (material or medium)"
was used to select worldwide relevant patent documents from Derwent database. Total 171 patents were uncovered; among those 15 are patent applications. The majority of found patents disclose polymer dispersed liquid crystal material.

The temporal distribution of patent documents is shown in Fig.7. Almost no activity is observed until the middle of 1990s when this technological area experienced a sharp rise of interest from researchers. The number of patent reached the top level of about 20 patents per year in 2000 and stays almost the same in the recent years. A small number of patent applications looks surprising. It definitely demonstrates that the technology attained certain maturity and probably came

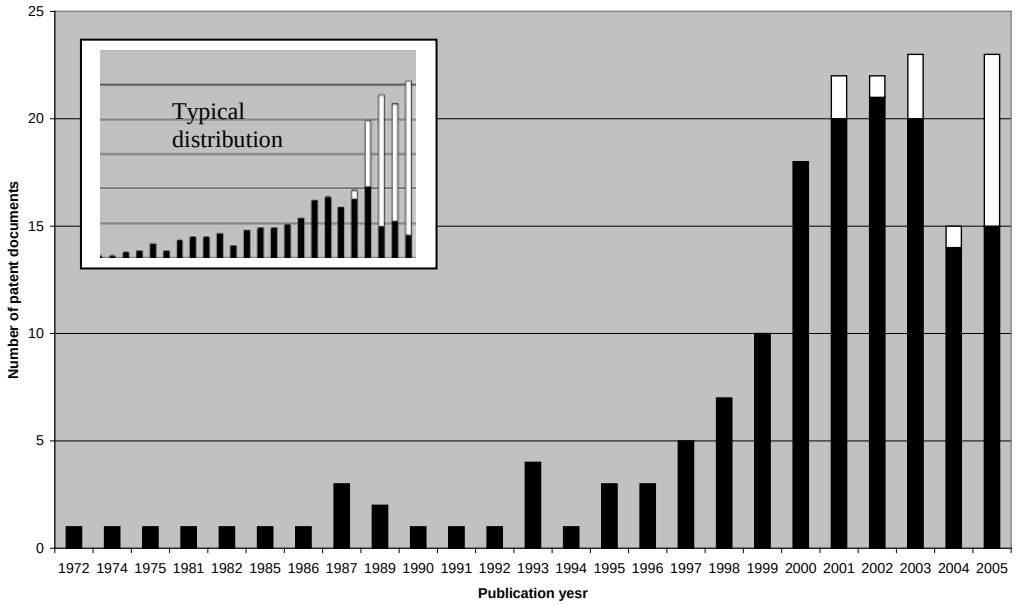


Fig.7 Publication year for patent documents on switchable holographic materials (black – patents, white – patent applications).

to the production stage. The typical temporal distribution for patents in optoelectronics is shown in the left upper corner of Fig. 7 for comparison purposes.

Fig. 8 and Fig. 9 show leading assignees for switchable holographic materials patents. Fig. 8 shows the assignees which names were printed in published patents. Companies Digilens and SAIC are clear leaders in the field. We have performed a special search for current assignees of these patent documents. The results are depicted in Fig.9. Patents of Digilens company had a long journey ended either in Intel's or in Hoya's IP departments. See in Table 5 an example of Digilens' patent US6323970 "Method of producing switchable holograms" reassignment in 2001-2004 retrieved from USPTO database.
First the patent was assigned to venture capital group who sponsored the research [6], then probably money was borrowed for it in credit corporation. Later the research team experienced reincarnation and appeared again as SBG labs (Switchable Bragg Gratings). And eventually the patent was sold to Intel Corporation.

Assignee	Date
DIGILENS	01/04/2001
GATX VENTURES	04/24/2001
TRANSAMERICA BUSINESS CREDIT CORPORATION	04/24/2001
SBG LABS	10/16/2003
INTEL CORPORATION	11/14/2004

Table 5. An example of patent assignment transaction.

Other transactions include acquiring of Waveform Research's patents by Agilent, Holoplex's patents by Aprilis, and Foster-Miller's IP by Hoya. Thus Hoya significantly improved its positioning in switchable hologram IP after purchase of Digilens' and Foster-Miller's patents. This may indicate the notion to start a manufacture line for this product.

It is interesting to observe that federal funding agencies like DARPA, NASA, NSF became the owners of the patents in this field. This indicates Government funding allocated for this type of holographic material.

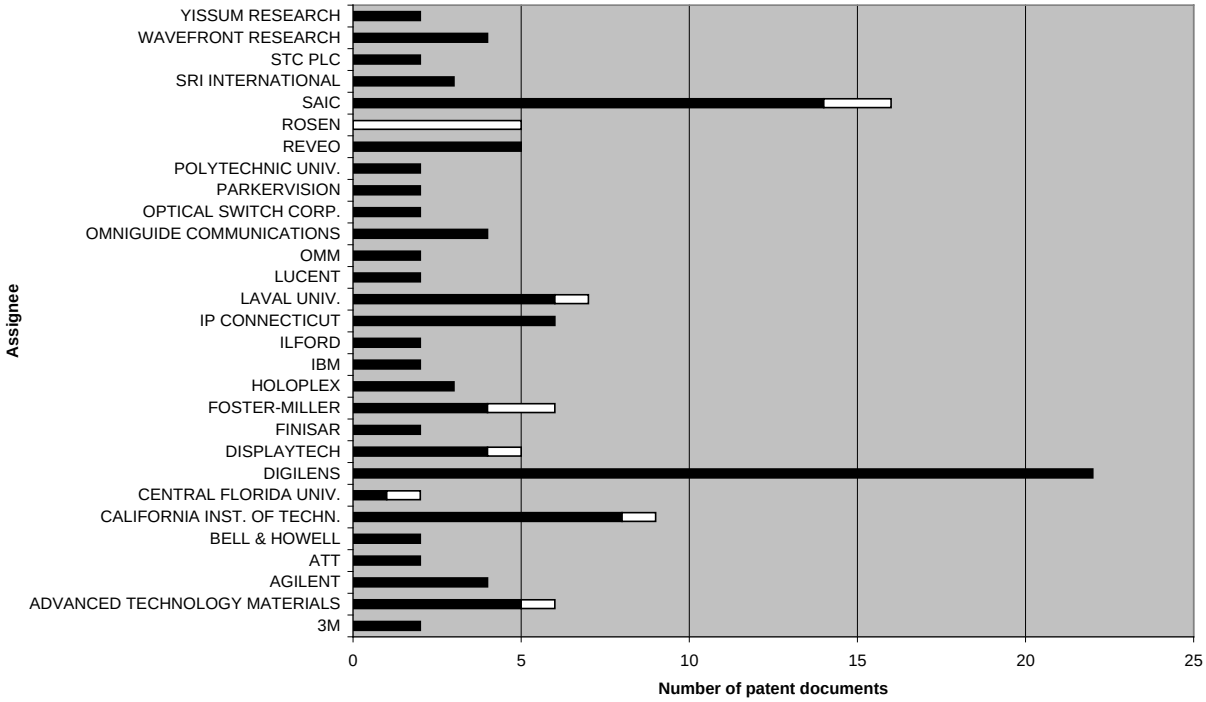


Fig. 8 Leading initial assignees in switchable holographic materials IP and number of patents they own (black – patents, white – patent applications).

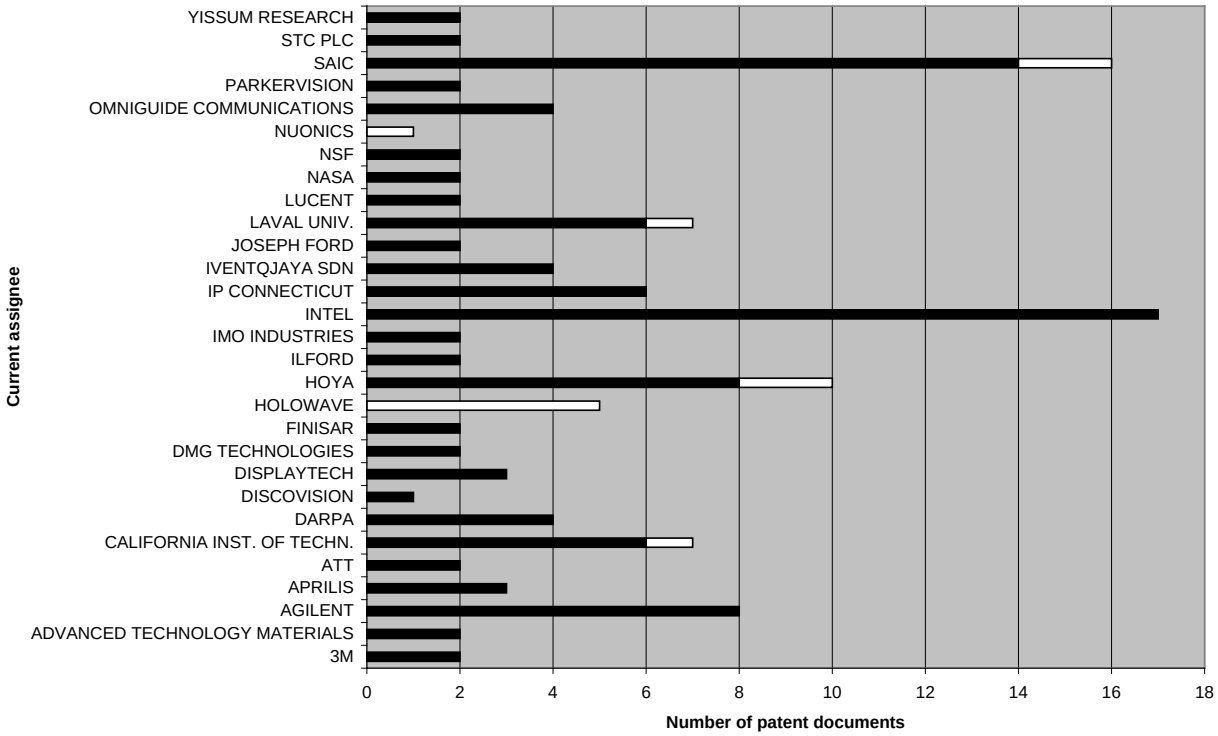


Fig. 9 Leading current assignees in switchable holographic materials IP and number of patents they own (black – patents, white – patent applications).

Analysis of backward and forward patent citations provides information on the most influencing patents in the field. See Fig.10 for the most important patents on switchable holographic materials. The level of importance was established basing on the number of forward references for the patents. We have selected only patent documents with 10 or more forward citations.

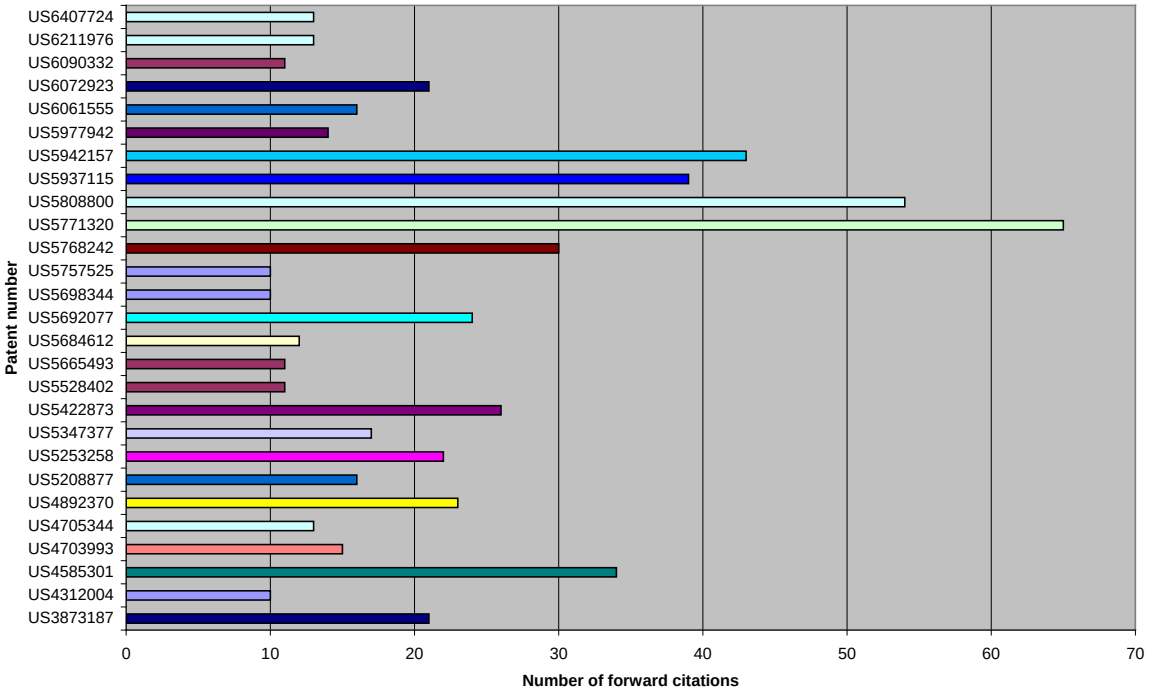


Fig. 10 Number of forwards citations for the most influencing patents in the field of switchable holograms.

This plot reflects the history of optical science. The most influencing patent turned to be the one that discloses switchable hologram application for telecom industry as a route switch.

Further analysis may include the search for the expert team in the field, which will include inventors who filed large amount of patents. The connection between research teams, companies and Universities can be established basing on their cooperation for the patent filing.

5. CONCLUSIONS

We have demonstrated the range of capabilities provided by patent search and analysis. Worldwide IP on holographic materials has been analyzed. It was shown that Ciba Specialty Chemicals Holding holds a predominate position in holographic materials IP owning 200 patent documents.

Japanese patent database has been analyzed as an example of national database analysis. A strong competition has been unveiled between TDK, Fuji, Sony and Pioneer companies. Almost all patent documents have been filed in the recent 5 years. The majority of patent documents is devoted to holographic data storage technologies.

One specific type of holographic media, switchable holographic material, has been analyzed in more details. Two major factors: the percentage of patent applications and the history of patent assignment transaction allows making a conclusion about a commercial product coming soon.

This paper allows to make an interesting observations and conclusions on the existing trends and development perspectives, to unveil the major trends in holographic materials business development.

6. REFERENCES

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