PatSnap Analytical Report

Liquid Crystals

patsnap

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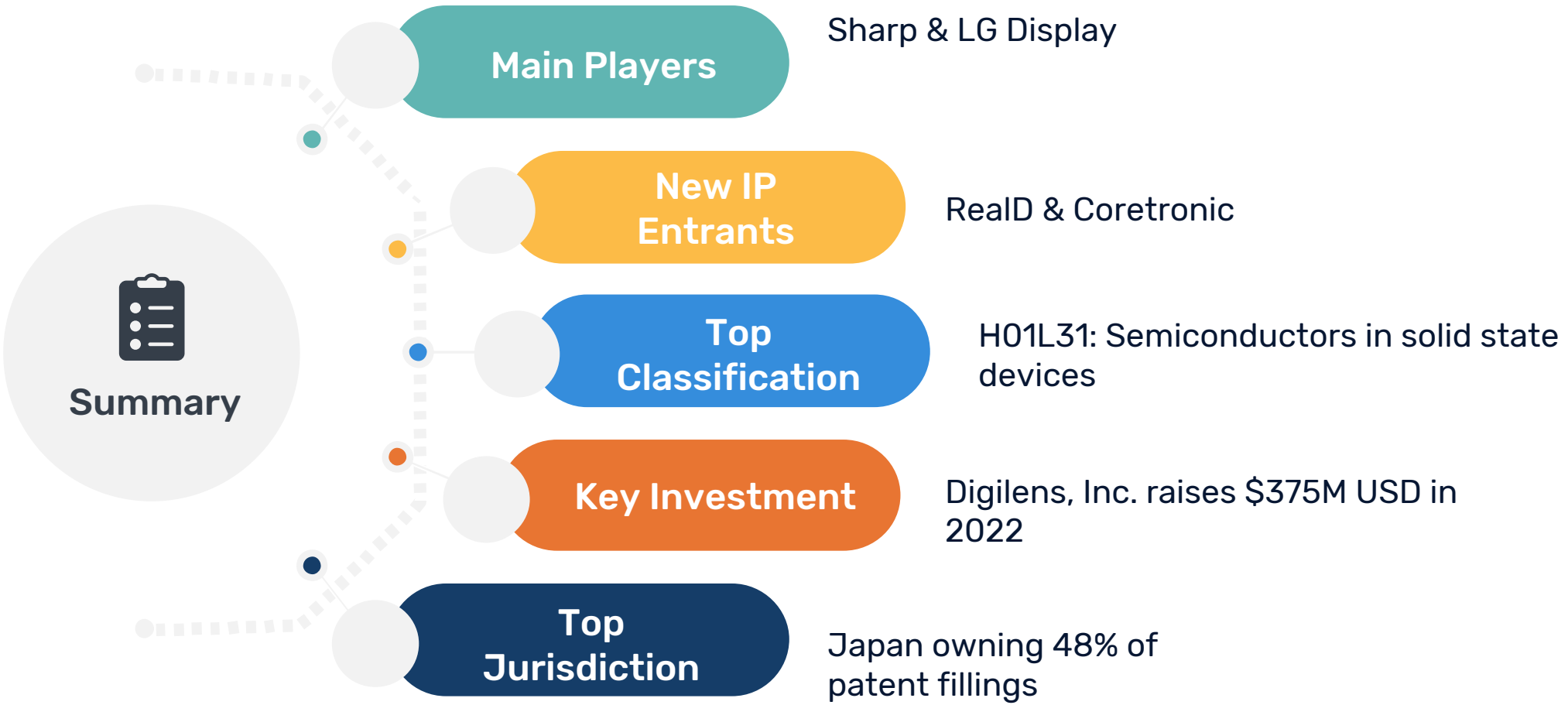
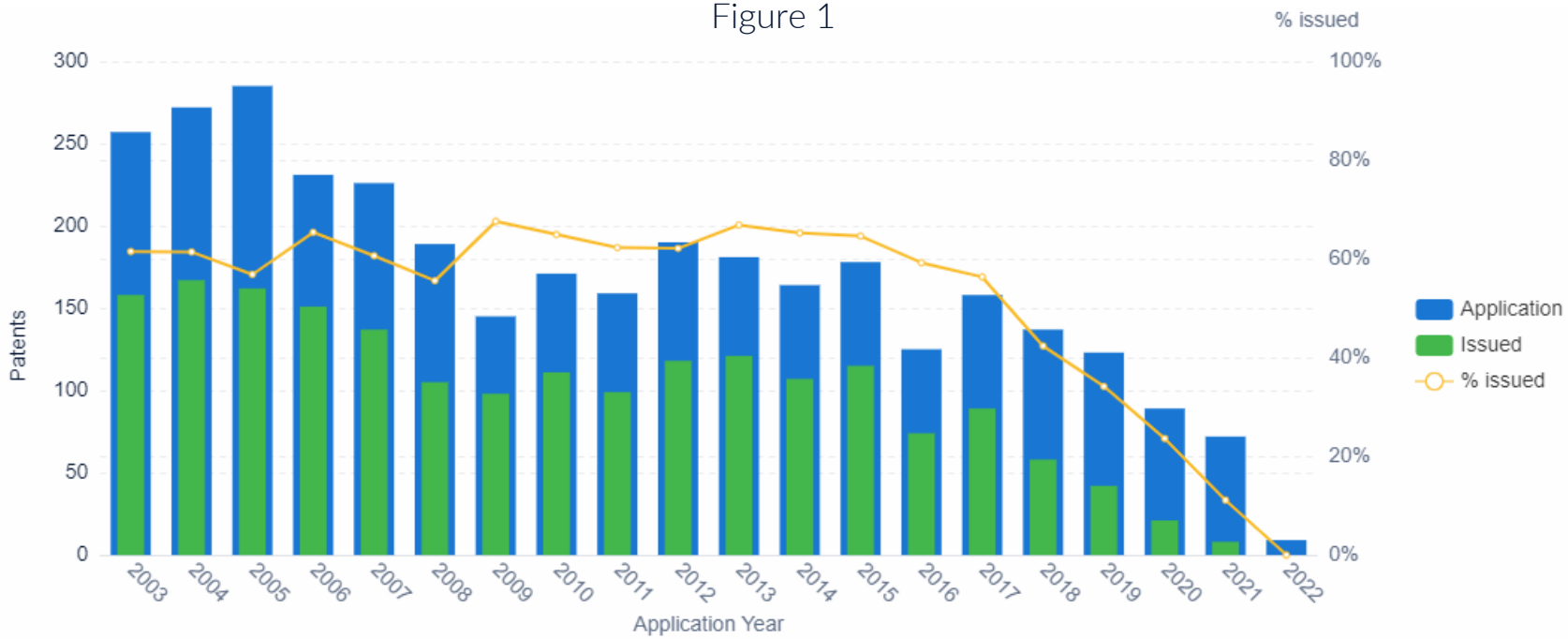
Executive Summary



Application Trends

Figure 1 illustrates the annual application trend for Liquid Crystal Alignment Layers between 2002 to 2022. The drop in patents during this time is due to the delay in granted applications (and likely the impact of COVID-19). The blue bars represent the number of patent applications, whereas the green bars represent the number of granted patents. The yellow trend line showcases the grant rate of the applied patents.

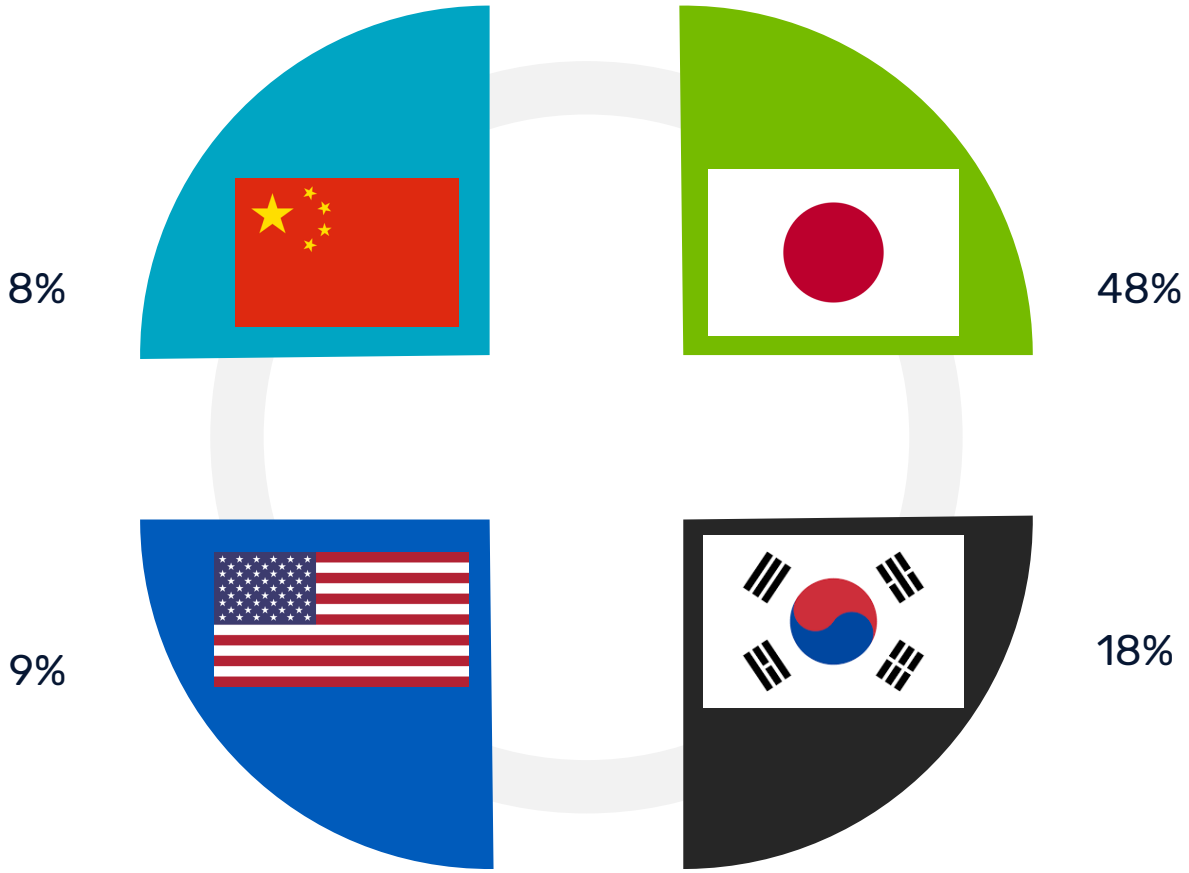
Figure 1



As you can see, the grant trend was relatively stable from 2002 until 2013. Then during the 2013 to 2014 time period, the grant rate dropped from 56.7% to 44.3%. In 2013, there was 1 patent pending and 2014, there were 14 patents pending. Even if these patents had been granted, the grant rates would only change to 57% and 48%, respectively. This indicates that the decrease in grant rates observed was not skewed by the remaining pending patents — instead, other factors influenced this decrease.

2005 represents the largest year for innovation, with 522 applications. The average value of these patents is $153,256 per application. Comparatively, the largest year for innovation in recent years is 2015, with 253 applications. The average value of these patents is $136,760 per application. As the average value of these patents is likely to increase over time as citations and potential licensing opportunities are seized, it is interesting to note that despite innovation decreasing over time, the value of these patents remain high. The most valued patents in 2005 and 2015 are: *Production and application of yarn and non strands of ribbon and sheet and nanofibers of the nanofiber* valued at $4,990,000 and: *Electro-optical devices using dynamic reconfiguration of effective electrode structures* valued at $4,530,000.

Jurisdiction Overview



Jurisdiction Analysis

Figure 2

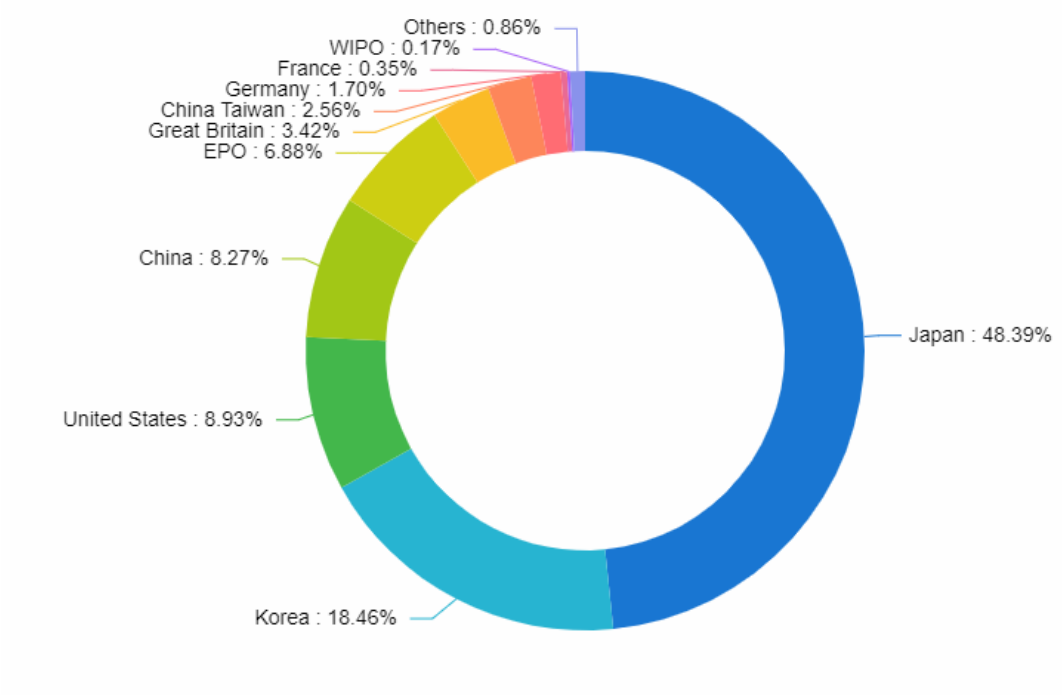


Figure 2 shows the country of origin of a patent, stipulating the location where a patent was first applied. This indicates the origination of the innovation. We see **Japan (JP) is the most innovative country with 48.39% of patent applications,** followed by Korea (KR) with 18.46%, and then the United States (US) with 8.93%. JP significantly leads the innovation in this sector, however, if we look at this trend over time, we see that a lot of this contribution is historical**. From 2015 to the present day, JP's innovation decreased significantly.** As a result, its innovation in this technology area is on par with other countries.

Out of the 3,751 applications originating in JP, 800 patents (21.3%) are active, while 2,613 patents (69.7%) are inactive, highlighting the historical nature of JP's innovation. If we look at the active patents, **JP still has the largest volume of active patents (800),** followed by KR (560) and CN (290).

Figure 3

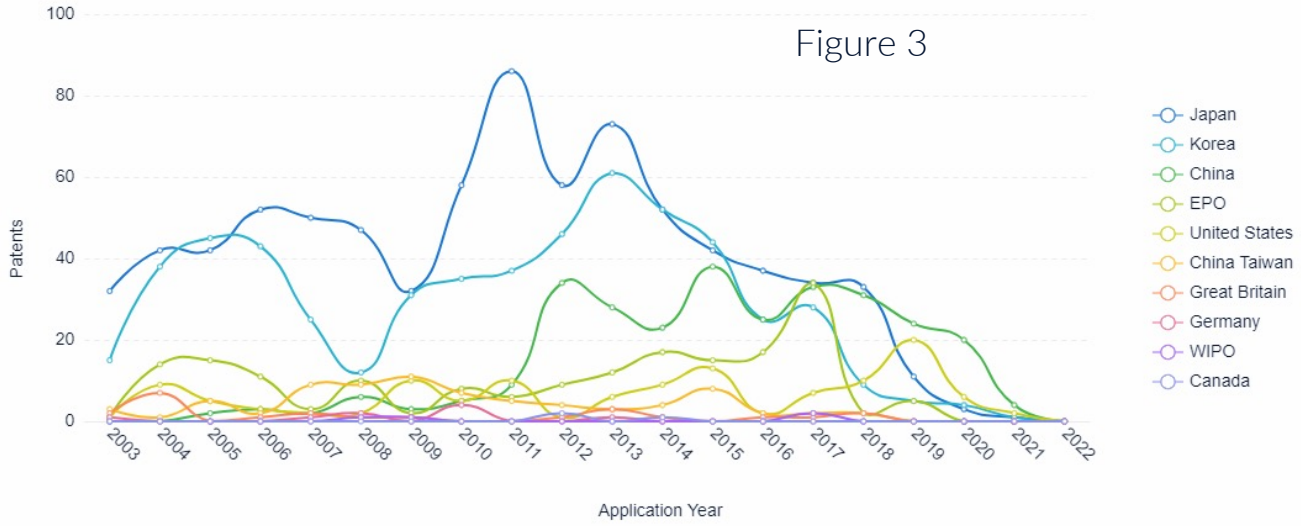


Figure 3 shows the application trend in the top countries, showing where the innovation is being filed. We see **patent fillings in JP decreased over time**, despite having the largest percentage of the market. Whereas CN remains relatively stable in yearly contributions to the market. In 2017, CN became the jurisdiction where the most patents were filed. This indicates that **CN is a becoming more important in this technology space.**

New Entrants

- RealD Cinema is the next generation of premium format and premium large format movie theaters, designed using RealD's foundational knowledge of 3D and curated with cutting-edge cinema technologies to deliver a truly immersive cinema experience.

- Coretronic is an innovative display solution provider. Coretronic was the first LCD backlight module manufacturer in Taiwan, and it has taken the lead in developing and mass-producing the smallest and lightest VGA single-panel LCD projectors and XGA DLP projectors in the world through integrated its leading technology.

- Facebook is committed to advancing a range of new technologies, focusing on AR/VR, Engineering, AI, and Gaming. The company's most recent patent, US20220171232A1, focuses on magnetic field driven liquid crystal patterning control systems.

New Entrants

Figure 5

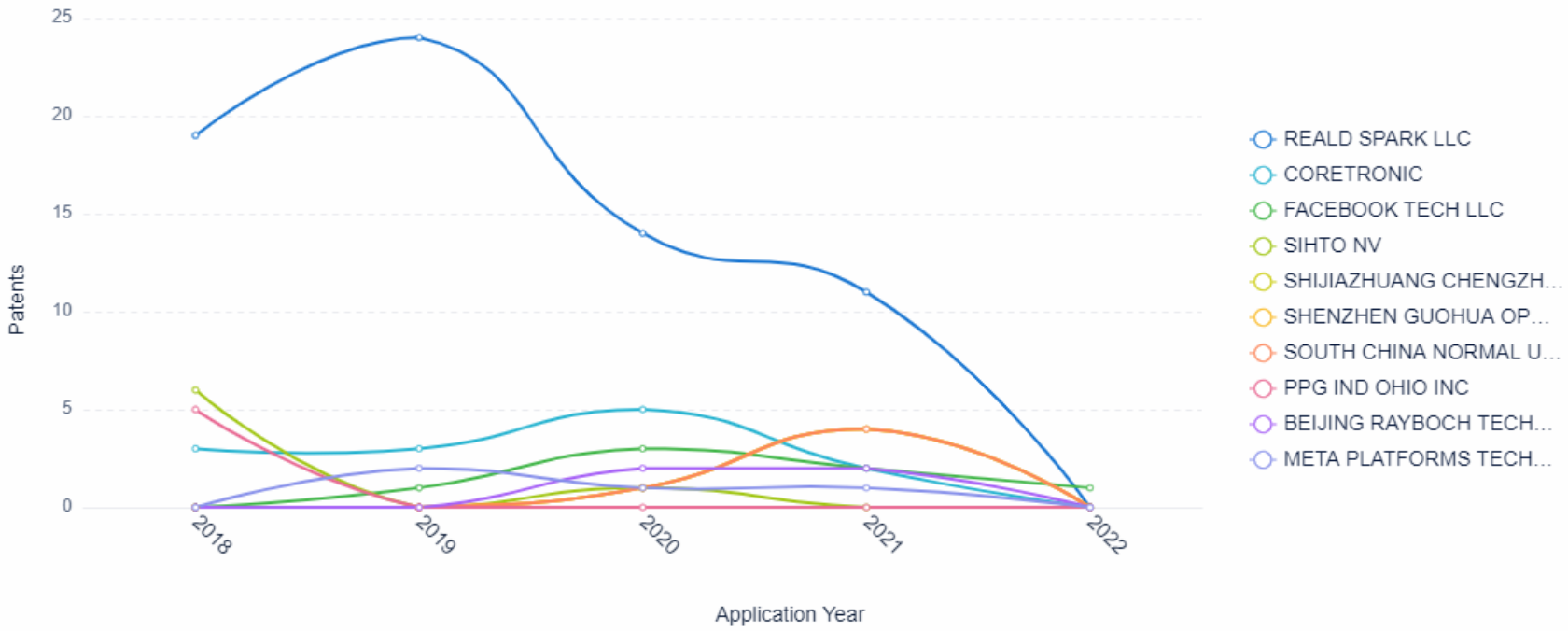


Figure 5 shows new market entrants, along with their filing trends (one document per application). A new entrant is defined as an assignee that has filed patents in the liquid crystal technology area for the first time in the last five years. Notably, Reald Spark LLC submitted 68 patent applications in our technology area since 2018, peaking with 24 in 2019.

Reald Spark LLC is the standardized current assignee on 154 simple patent families, consisting of 718 applications. Though active prior to 2018 in the display device fields, this is the first time this assignee filed in this technology space showing that **the field of liquid crystals is an emerging technology for them**. The company's most valuable patent in this area is *(Optical Stack for Switchable Directional Display),* which is valued at $960,000.

Top Assignees

- Patent Portfolio Size: 503 Simple Families
- Percentage of Active Patents: 30%
- Top IPC code: G02F1/1337
- Top filing jurisdiction: JP

- Patent Portfolio Size: 410 Simple Families
- Percentage of Active Patents: 44%
- Top IPC code: G02F1/1337
- Top filing jurisdiction: KR

- Patent Portfolio Size: 196 Simple Families
- Percentage of Active Patents: 54%
- Top IPC code: G02F1/1337
- Top filing jurisdiction: KR

- Patent Portfolio Size: 170
- Percentage of Active Patents: 51%
- Top IPC code: C09K19/04
- Top filing jurisdiction: DE

- Patent Portfolio Size: 155
- Percentage of Active Patents: 15%
- Top IPC code: G02B5/30
- Top filing jurisdiction: JP

Key Patents

Brief explanation of key patent selection criteria

Publication Number	Title	Estimated Expiration Date	Valuation	Cited by Simple Family Count	Simple Legal Status	Current Assignee
US9481949B2	Fabrication and application of nanofiber ribbons and sheets and twisted and non-twisted nanofiber yarns	2025	$8,460,000	1926	Active	
US9389465B2	Liquid crystal display device and method of manufacturing	2029	$8,190,000	128	Active	Panasonic
US7359104B2	Polarizing, photochromic devices and methods of making the same	2024	$8,160,000	499	Active	Transitions light intelligent lenses
US7560124B2	Photochromic compounds	2024	$7,150,000	341	Active	Transitions light intelligent lenses

Japan Display Inc Vs. Hitachi Ltd

Japan Display is comprised of ten subsidiaries. Interestingly, **Hitachi Display, Ltd was acquired from Hitachi Ltd, which ranks among the top 10 assignees**. Both companies may operate in the same geographical region, Tokyo, JP, however, upon comparison, **Hitachi Ltd possesses a higher market capitalization ($28.13 Billion, as of March 31st, 2020) than Japan Display ($384.08 Million, as of March 31st, 2020), which is attributed to the maturity of the company, where Japan Display was founded in 2012 and Hitachi in 1959**. The companies have similar patent valuations, where Japan Display has a considerably low patent count of 14,221 patent applications. Thus, we can deduce that Japan Display is filling fewer, more valuable patent applications.

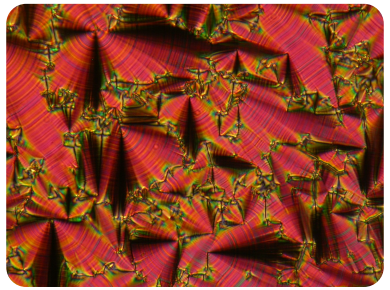
JDI
Japan Display Inc.

HITACHI
Inspire the Next

Importantly, **Japan Display possesses 17 active patents valued at more than $1,000,000 USD within the G02F1 technology area**, with respect to liquid crystals. This includes a recent patent application filled in 2018 (US20180292722A1) which encompasses a liquid crystal display device in which the reduction in transmissivity is small ($2,540,000). A key assignee, Sharp KK has cited this innovation in a recent patent application, US10642117B2 which went on to become a public document. **Noteworthy active patents with a lot of citations include: US20090289260A1, US20140293175A1, JP2012226249A, and US20130088675A1**. Many of these patents are cited by key competitors, such as Boe Tech Grp Co Ltd, Samsung Display Co Ltd, Sharp KK, LG Display Co Ltd, among others.

Investment Overview

Company Name	Investor	Date	Amount
Digilens, Inc.	Samsung Electronics Co,. Ltd +5 others	07 Apr 2022	$50M USD
FlexEnable Ltd.	Coretronic Corp.	22 Feb 2022	$11M USD
Guazy Ltd	Avery Dennison Corp +5 others	08 Feb 2022	$70M USD
SmartKem Ltd.	Octopus Ventures Ltd.	27 Jan 2022	$2M USD
Kent Displays, Inc.	Korea Evaluation Institute of Industrial Technology	17 Aug 2021	$380M USD



End Notes

The query used to gather relevant results:

Main Query:

TAC_ALL:(((Liquid $W1 Crystal*) $W7 (material* OR Phase OR Medium)) AND ((Display OR Optical) $W2 (Panel OR Device OR Sheet)) AND (Align* $W3 (Layer OR Method OR Plane OR System))) AND (IPC:(G02F1/13 OR C09K19) OR CPC:(G02F1/13 OR C09K19))

Discovery Query:

Keyword: (Liquid Crystal OR LC) AND (Display Device OR Display OR Screen)

Connecting the dots so you can innovate better

Founded in 2007, PatSnap is the company behind the world's leading Connected Innovation Intelligence platform. PatSnap is used by more than 10,000 customers in over 50 countries around the world to access market, technology, and competitive intelligence as well as patent insights needed to take products from ideation to commercialization. Customers are innovators across multiple industry sectors, including Biotechnology, Medical devices, Pharmaceuticals, Chemical, Electronics Manufacturing, Automotive, Consumer Goods, Aviation & Aerospace, Education, and Legal Firms.

PatSnap's team of 1000+ employees work from its global headquarters in Singapore, London, and Toronto. To learn more about how PatSnap is improving the way companies innovate, visit .

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