Certainty in Search and Cooperative Patent Classification

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Technology Center Lead for Classification, Semiconductor Workgroup

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Primary Patent Examiner
CPC Quality Nominee and TC 2800 Trainer
An application is docketed to the examiner – now what?
IN THE CLAIMS

1. (Currently amended) An apparatus comprising:
   - a first die,
   - a thermal cooler formed disposed over at least a portion of the first die;
   - a second die formed disposed over at least a portion of the thermal cooler, and
   - a plurality of through-silicon vias providing electrical connections between the first die and the second die;

   wherein the thermal cooler comprises a plurality of fluid channels for fluid cooling of the first die and the second die, each of the plurality of fluid channels being-formed disposed horizontally through the thermal cooler; and

   wherein the plurality of through-silicon vias are formed disposed vertically through the first die, the thermal cooler and the second die;

   wherein the thermal cooler comprises a first silicon wafer die half and a second silicon wafer die half, each of the first silicon wafer die half and the second silicon wafer die half comprising a plurality of vias disposed in outer edge portions thereof and a plurality of trenches disposed in an inner portion thereof, the outer edge portions of the first silicon wafer die half and the second silicon wafer die half surrounding the inner portions of the first silicon wafer die half and the second silicon wafer die half respectively, and

   wherein the first silicon wafer die half and the second silicon wafer die half are thermocompression bonded to connect the plurality of vias disposed in the outer edge portions thereof to one another forming connected pairs of vias and to connect the plurality of trenches disposed in the inner portions thereof to one another forming connected pairs of trenches, each connected pair of trenches providing one of the plurality of microchannel coolers and each connected pair of vias providing a portion of one the plurality of through-silicon vias.
1. An apparatus comprising:
   a first die;
   a thermal cooler formed over at least a portion of the first die;
   a second die formed over at least a portion of the thermal cooler; and
   a plurality of through-silicon vias providing electrical connections between the first and second dies;
   wherein the thermal cooler comprises a plurality of fluid channels for fluid cooling of the first die and the second die, the plurality of fluid channels being formed horizontally through the thermal cooler; and
   wherein the plurality of through-silicon vias are formed vertically through the first die, the thermal cooler and the second die.

1202 - silicon housing of heat sinks
1206-1 through 1206-3 - silicon wafers (heat sinks) having channels 1224 for fluid coolant therein
104, 108, 110 - silicon dies (IC chips)
1216 - TSV in all chips and heat sinks
118 - bumps connecting vertical TSVs (claimed in dependent claims)
Now the examiner starts to “search” – but what does that mean?
Why do Examiners search?

• Determine the state of the art
• Facilitate claim interpretation
  – e.g. what else could the claim cover under BRI?
• Identify relevant prior art
• Determine allowability of an application
How are search strategies developed?

• **Claim interpretation**
  – Read and understand the claimed invention
  – Determine the scope of the claimed invention

• **Review of the cited prior art**
  – Information disclosure statements, 3rd party submissions

• **Review of patent family documents (foreign or domestic)**

• **Review Classification Picture**

• **Review Non-Patent Literature**

• **Consultation with other examiners**
Where do Examiners search?

• US and International Patent Literature databases, e.g. USPTO databases via EAST/WEST, WIPO, EPO, JPO, etc.

• Non-Patent Literature Searching
  • Anywhere an examiner might find the information they need with evidence of the date of publication or availability. For example: publications, peer-reviewed journal articles, web sites, online libraries, etc.
F-term
What do EAST searches look like?
1. An apparatus comprising:
   a **first die**;
   a **thermal cooler** formed over at least a portion of the first die;
   a **second die** formed over at least a portion of the thermal cooler; and
   a plurality of **through-silicon vias** providing electrical connections between the first and second dies;

   wherein the thermal cooler comprises a plurality of **fluid channels for fluid cooling** of the first die and the second die, the plurality of fluid channels being **formed horizontally through the thermal cooler**; and

   wherein the plurality of **through-silicon vias** are formed **vertically through the first die, the thermal cooler and the second die**.

1202 - silicon housing of heat sinks

1206-1 through 1206-3 - silicon wafers (**heat sinks**) having channels 1224 for fluid coolant therein

104, 108, 110 - silicon dies (IC chips)

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1. An **apparatus** comprising:
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   wherein the plurality of **through-silicon vias** are formed **vertically through the first die, the thermal cooler and the second die**.

L1: (thermal near3 cooler)
1. An apparatus comprising:
   a first die;
   a thermal cooler formed over at least a portion of the first die;
   a second die formed over at least a portion of the thermal cooler; and
   a plurality of through-silicon vias providing electrical connections between the first and second dies;
   wherein the thermal cooler comprises a plurality of fluid channels for fluid cooling of the first die and the second die, the plurality of fluid channels being formed horizontally through the thermal cooler; and
   wherein the plurality of through-silicon vias are formed vertically through the first die, the thermal cooler and the second die.

L2: ((thermal near3 cooler) OR (cool$3 near3 (apparatus or device)) OR heat$1sink OR ((thermal or heat) near3 (sink$3 or dump$3))
1. An **apparatus** comprising:
   a **first die**;
   a **thermal cooler** formed over at least a portion of the first die;
   a **second die** formed over at least a portion of the thermal cooler; and
   a plurality of **through-silicon vias** providing electrical connections between the first and second dies;
   wherein the thermal cooler comprises a plurality of **fluid channels for fluid cooling** of the first die and the second die, the plurality of fluid channels being **formed horizontally through the thermal cooler**; and
   wherein the plurality of **through-silicon vias** are formed **vertically through the first die, the thermal cooler and the second die**.

L3: L2 AND

((second or top or upper$4) near3 (die or chip)) AND
((first or bottom or lower$4) near3 (die or chip))
1. An apparatus comprising:
a first die;
a thermal cooler formed over at least a portion of the first die;
a second die formed over at least a portion of the thermal cooler; and
a plurality of through-silicon vias providing electrical connections between the first and second dies;
wherein the thermal cooler comprises a plurality of fluid channels for fluid cooling of the first die and the second die, the plurality of fluid channels being formed horizontally through the thermal cooler; and
wherein the plurality of through-silicon vias are formed vertically through the first die, the thermal cooler and the second die.

L4: L3 AND
((liquid or fluid) near3 (passage$4 or tube or channel))
4. Devise search queries to find the claimed or disclosed invention.

5. Text Searching

Text searching is a useful type of searching.

However, if the prior art uses terms the examiner does not include in the text search, the prior art can not be found.

This limitation of text searching can be remedied by including **CPC searching** as a part of a complete and quality search.
1. An apparatus comprising:
   a first die;
   a thermal cooler formed over at least a portion of the first die;
   a second die formed over at least a portion of the thermal cooler; and
   a plurality of through-silicon vias providing electrical connections between the first and second dies;
   wherein the thermal cooler comprises a plurality of fluid channels for fluid cooling of the first die and the second die, the plurality of fluid channels being formed horizontally through the thermal cooler; and
   wherein the plurality of through-silicon vias are formed vertically through the first die, the thermal cooler and the second die.

L5: H01L23/473.cpc.


L7: H01L23/473.cpc. AND H01L2225/06589.cpc. AND H01L2225/06541.cpc.
What electronic tools does an examiner use for Search?

• Docket and Application Viewer (DAV)
  – View application’s documents
• Search Tools (EAST/WEST, other electronic databases)
What electronic tools does an examiner use for Search?

- Docket and Application Viewer (DAV)
  - View application’s documents
- Search Tools (EAST/WEST, other electronic databases)
- Classification Allocation Tool (CAT)
  - View application’s classification information
- CPC Scheme Navigator
  - Review scope of classification information
- Semiconductor Topical Index
Nexus of Classification & Search

- Classification groups similar technologies for quick and efficient retrieval
- Crosses and connects different languages, semantics, spellings, etc. in a language neutral manner
- Links multiple national offices and publications
- USPTO used to use USPC but now uses CPC
How does CPC searching work?
Transitioning from USPC to CPC

USPC was globally and locally hierarchical (therefore asymmetric)

CPC is symmetric down to the main group level

This structure of CPC allows use of classification picture as a tool, e.g. different approach for searching, understanding growth areas, defining related art communities.............
CPC is a “language neutral” system designed to collect all useful documents relating to a concept in a single place, regardless of the text synonyms the documents use to describe the concept, and regardless of the preferred synonyms of the classifier.
Simple Example

**CPC subgroups describe features or groups of features**
- A subgroup represents metadata – it tags the documents with a feature.
- All documents in each subgroup share that feature.

A The area of A indicates all documents having the attributes of A – all hammers.

The area of B indicates all documents having the attributes of B – the handle attachment.

The area of C indicates all documents having the attributes of C – type of grip & types of tools included in subgroup.
An “intersection” CPC subgroup search is a search where you search the overlap between two or more subgroups.

The intersection of \(A\) and \(B\), given by “\(A\) and \(B\)”, is the purple region of overlap.

The intersection is a subset of \(A\) and a subset of \(B\). The intersection requires all of the properties of both subgroups.
An “intersection” CPC subgroup search is a search where you search the overlap between two or more subgroups.

The intersection of A, B, and C, given by “A and B and C”, is the darkest purple region of overlap.

The intersection is a subset of each of the three subgroups. The intersection requires all of the properties of all three subgroups.
What does a CPC search actually look like?

L5: H01L23/473.cpc.


L7: H01L23/473.cpc. AND H01L23/481.cpc. AND H01L2225/06589.cpc.

Benefits: these searches
1) do not rely on text semantics,
2) do not rely on text language or spelling that Applicants used,
3) do not rely on text synonyms that prior art references used,
4) utilize classifiers’ intellectual effort
How do CPC symbols get applied to an application?
## Classification Allocation Tool (CAT)

### Results: Application Number 14981120

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**Examiner:**

- Kevin Paredo

**Contractors:**

- US EXPERT
- EPO

**EPO:**
The classification picture (i.e. the set of allocations) changes over time.

Initially (Aug. 2016) the contractor made 13 allocations.

The US examiner added 12 allocations at the time of the FAOM (Dec. 2016).

In November 2017, the EPO examiners from H01L 25 added 2 allocations.

Later, in March, 2018, the EPO examiners from H01L 24 added 19 allocations and 5 combination sets.
How do examiners find symbols to apply?
The main Scheme Navigator page may be entered directly via the URL https://www.cpc-ce.org/#/schemeNavigator.
The scheme navigator is a good tool to view a symbol’s hierarchy. We have seen that previously, as accessed by CAT. To do so from the main Scheme Navigator page, merely enter in the symbol information at the upper left corner and click “submit”.
The scheme navigator allows for good searches. You may search the titles, notes/warnings, and/or definitions of the scheme. You may optionally limit the search to H01L, H01L 27/00, etc., by entering that information in the “symbol search” box. If you do not put an entry in “symbol search”, the entire CPC scheme will be searched. You can use ? or * as a wildcard. The search utilizes the Boolean operators AND, OR, NOT.
Once you have searched, key-word-in-context search results appear. You may click on one and show the hierarchy to see the full scope of the subgroup.
The scheme definitions may be viewed in the scheme navigator.
The Semiconductor Topical Index orders topics and subtopics in the general order of the H01L scheme. The language that is used is generally simpler than is used in the CPC scheme. Also, it is much easier and quicker to find the topics that you want to find than it is to find them in the scheme itself. The topics are generally ordered in the order of H01L.
One can quickly expand through topics and subtopics in order to find a desired idea. For instance, one may find liquid deposition by choosing universal methods / Deposition. Clicking on liquid deposition gives the subtopics under it, such as printing, spraying, etc. The locations in CPC are listed in the “allocations” column.
The Semiconductor Topical Index is searchable. The results come up in context of the index, with the search term highlighted.
Hidden synonyms enable relevant topics to be found, even if the searched term does not exactly match the topic's title. This ensures that relevant CPC subgroups may be found even if a user does not know the terminology used by the CPC scheme or by the Semiconductor Topical Index.
Imagine these are the synonyms you know, or that you gather from references in preliminary searches. If these are the only synonyms you text search for, you will miss prior art that use other terms.
Searching CPC fills in the gaps

Application: “Apparatus” with “thermal cooler”

Reference: uses synonym “heatsink”

Reference: uses synonym “heatsink”

Reference: uses synonym “heatsink”

Reference: uses synonym “heatsink”

Reference: uses synonym “heatsink”

Reference: Image-only and not text-searchable, but discusses cooler

Reference: misspells a term or has bad OCR e.g. “heatsinh”

H01L 29/3675
Arrangement for cooling semiconductor device, facilitated by shape of housing
CPC is a “language neutral” system designed to collect all useful documents relating to a concept in a single place, regardless of the text synonyms the documents use to describe the concept, and regardless of the preferred synonyms of the classifier.
Application: “Apparatus” with “thermal cooler”

Reference: uses synonym “heatsink”

Reference: uses synonym “heat exchanger”

Reference: Discloses “thermal reservoir” for halogen light bulb

Reference: Discloses “heatsink” only generically in background without useful information

Reference: Discusses a “cooler” in terms of a beverage container

H01L 29/3675
Arrangement for cooling semiconductor device, facilitated by shape of housing
The effective use of CPC provides the examiner and the Applicant more certainty and confidence that a complete, quality search of the prior art has been performed because it is language neutral.
Applying CPC to Search: Example Application
1. An **apparatus** comprising:
   a **first die**;
   a **thermal cooler** formed over at least a portion of the first die;
   a **second die** formed over at least a portion of the thermal cooler; and
   a plurality of **through-silicon vias** providing electrical connections between the first and second dies;
   wherein the thermal cooler comprises a plurality of **fluid channels for fluid cooling** of the first die and the second die, the plurality of fluid channels being **formed horizontally through the thermal cooler**; and
   wherein the plurality of **through-silicon vias** are formed **vertically through the first die, the thermal cooler and the second die**.

![Diagram of thermal apparatus](image-url)
### Step 1: View the classification picture in the Classification Allocation Tool

#### Classification Picture

**Results:** Application Number 14981120

- **Family ID:** 5908843
- **View Classification PDF**
- **View Issue Classification PDF**
- **Save Issue Classification to MyED Folder**

**Allocations (27)**

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</tr>
</tbody>
</table>
The scope of the subgroup **H01L 23/3738** is the sum of each subgroup it depends from in its hierarchy:

An arrangement for cooling a semiconductor or solid state device, the cooling being facilitated by a semiconducting material in the arrangement.
The classification picture (i.e. the set of CPC allocations) changes over time.

Initially (August, 2016) the contractor made 13 allocations.

At the time of the initial search (Dec. 2016), the US examiner added 12 allocations.

In November 2017, the EPO examiners from H01L 25 added 2 allocations.

In March 2018, the EPO examiners from H01L 24 added 19 allocations and 5 combination sets.

3 allocations were deleted.

Step 3: Determine if any subgroups have been incorrectly allocated.

Step 4: Determine if pertinent subgroups have not been allocated yet.
What follows is a partial classification picture of the *disclosed invention* (i.e. subjectively the “best” subgroups) [the full scope of each subgroup is summarized]

<table>
<thead>
<tr>
<th>Classification Code</th>
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<tbody>
<tr>
<td>H01L 23/473</td>
<td>Arrangement for cooling or heating using flowing liquid</td>
</tr>
<tr>
<td>H01L 23/3738</td>
<td>Arrangement for cooling made of semiconductor material</td>
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<tr>
<td>H01L 2225/06589</td>
<td>Stacks of integrated circuit chips having thermal management</td>
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<tr>
<td>H01L 23/481</td>
<td>Through silicon via in a semiconductor device</td>
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<td>Bump connector electrically connecting stacked semiconductor chips</td>
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<td>H01L 2225/06517</td>
<td>Stacks of integrated circuit chips having a bump direct electrical connection between a device and a substrate</td>
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</tbody>
</table>
Step 5: Devise CPC searches from the correct, pertinent subgroups

Step 6: Perform CPC search by combining subgroups to match a large portion of the invention’s scope. Repeat by trying various promising combinations.

Sometimes the devising of the search strategy happens initially. It is often informed by trying combinations and seeing how many documents are yielded by the search.

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</tr>
</tbody>
</table>
1. An **apparatus** comprising:
   a **first die**;
   a **thermal cooler** formed over at least a portion of the first die;
   a **second die** formed over at least a portion of the thermal cooler; and
   a plurality of **through-silicon vias** providing electrical connections between the first and second dies;

   wherein the thermal cooler comprises a plurality of **fluid channels for fluid cooling** of the first die and the second die, the plurality of fluid channels being **formed horizontally through the thermal cooler**; and

   wherein the plurality of **through-silicon vias** are formed **vertically through the first die, the thermal cooler and the second die**.

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</tr>
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<td><strong>Stacks of integrated circuit chips</strong> having <strong>TSV</strong> connections therein</td>
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1. An **apparatus** comprising:
   a **first die**;
   a **thermal cooler** formed over at least a portion of the first die;
   a **second die** formed over at least a portion of the thermal cooler; and
   a plurality of **through-silicon vias** providing electrical connections between the first and second dies;
   wherein the thermal cooler comprises a plurality of **fluid channels for fluid cooling** of the first die and the second die, the plurality of fluid channels being **formed horizontally through the thermal cooler**; and
   wherein the plurality of **through-silicon vias** are formed **vertically through the first die, the thermal cooler and the second die**.

*CPC search L5: H01L23/473.cpc.*
searches for arrangement for cooling or heating, using flowing liquid, of a semiconductor or solid state device

A L1 could be searched individually in its entirety
1. An **apparatus** comprising:
   a **first die**;
   a **thermal cooler** formed over at least a portion of the first die;
   a **second die** formed over at least a portion of the thermal cooler; and
   a plurality of **through-silicon vias** providing electrical connections between the first and second dies;

   wherein the thermal cooler comprises a plurality of **fluid channels for fluid cooling** of the first die and the second die, the plurality of fluid channels being **formed horizontally through the thermal cooler**; and

   wherein the plurality of **through-silicon vias** are formed **vertically through the first die, the thermal cooler and the second die**.

**CPC search L5: H01L23/473.cpc.**
searches for arrangement for cooling or heating, using **flowing liquid**, of a semiconductor or solid state device

L5 returns 14,272 documents, which is too many to search through.

L5 is **not efficient** to search, because it is too broad to capture the important elements of the claim.

For example, it does **not** require the TSVs, and only requires a single chip instead of a stack of plural chips.
1. An apparatus comprising:
   a first die;
   a thermal cooler formed over at least a portion of the first die;
   a second die formed over at least a portion of the thermal cooler; and
   a plurality of through-silicon vias providing electrical connections between the first and second dies;
   wherein the thermal cooler comprises a plurality of fluid channels for fluid cooling of the first die and the second die, the plurality of fluid channels being formed horizontally through the thermal cooler; and
   wherein the plurality of through-silicon vias are formed vertically through the first die, the thermal cooler and the second die.

Thus, it would be better to do intersection searches that more completely match the scope of the claimed invention.
1. An **apparatus** comprising:
   a **first die**;
   a **thermal cooler** formed over at least a portion of the first die; and
   a **second die** formed over at least a portion of the thermal cooler; and
   a plurality of **through-silicon vias** providing electrical connections between the first and second dies;
   wherein the thermal cooler comprises a plurality of **fluid channels for fluid cooling** of the first die and the second die, the plurality of fluid channels being **formed horizontally through the thermal cooler**; and
   wherein the plurality of **through-silicon vias** are formed **vertically through the first die, the thermal cooler and the second die**.

This claim is essentially described by four **concepts**:
- Stacked chips
- Heat sink
- Channels for fluid coolant in the heat sink
- TSVs connecting the chips to each other and to the heat sink
This claim has four different concepts:

- **Stacked chips**
- **Heat sink**
- **Channels for fluid coolant in the heat sink**
- **TSVs connecting the chips to each other and to the heat sink**

Which parts of this partial classification can cover these four concepts?

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This claim has four different concepts:
• Stacked chips
• Heat sink
• Channels for fluid coolant in the heat sink
• TSVs connecting the chips to each other and to the heat sink

Which parts of this partial classification picture most specifically cover these four concepts?

| H01L 23/473 | Arrangement for cooling or heating using flowing liquid |
| H01L 23/3738 | Arrangement for cooling made of semiconductor material |
| H01L 25/0657 | Stack of integrated circuit chips |
| H01L 2225/06589 | Stacks of integrated circuit chips having thermal management |
| H01L 23/481 | Through silicon via |
| H01L 2225/06541 | Stacks of integrated circuit chips having TSV connections therein |
| H01L 24/16 | Bump connector electrically connecting stacked semiconductor chips |
| H01L 2225/06517 | Stacks of integrated circuit chips having a bump direct electrical connection between a device and a substrate |
This claim has four different concepts:

- Stacked chips
- Heat sink
- Channels for fluid coolant in the heat sink
- TSVs connecting the chips to each other and to the heat sink

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**Better CPC search (intersection search):**

L7: H01L23/473.cpc. AND H01L2225/06589.cpc. AND H01L2225/06541.cpc.

L7 covers all four concepts using three CPC subgroups.
US 2016/0056089 A1 ("Taniguchi") has a "heat spreading member" 30, stacked chips, silicon substrates 25 and 26 with "cooling channels" S therein, in a geometry that very closely matches the disclosed invention.
A condensed search showing some text searching
A condensed list of some relevant CPC subgroups

- L1: (93) L1 and (heat$|slink or ((heat or thermal$) adj (sink or dump or reservoir)))
- L5: (14) L1 and (heat$|slink or ((heat or thermal$) adj (sink or dump or reservoir)))
- L6: (111) IBM or (international and business and machines) or, and (heat$|slink or ((heat or thermal$) adj (sink or dump or reservoir)))
- L11: (16,212) ((first or lower or bottom) near3 (die or chip)) and ((second or top or up) near2 (heat$|slink or (heat or thermal$)
- L12: (74) ((stack$3 or assembled$3) near5 (die or chip)) and (heat$|slink or (heat or thermal$))
- L19: (1,156) ((stack$3 or assembled$3) near5 (die or chip)) and (heat$|slink or (heat or thermal$))
- L20: (14,980) ** CPC subgroup for heatsink with flowing liquid
- L21: (579) ** CPC subgroup for heatsink made of semiconductor
- L22: (5,350) ** CPC subgroup for stack of IC chips with thermal management
- L23: (23,984) ** CPC subgroup for TSV
- L24: (16,838) ** CPC subgroup for stack of IC chips with TSVs therein
- L25: (4,832) ** CPC subgroup for a pyramidal geometry of stacked IC chips
- L26: (5,679) ** CPC: carrier with electrical interconnections between stacked chips

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H01L2225/06572.cpc
Some example CPC intersection searches. Various combinations cover different overall scopes.
Thank You!