

UNITED STATES DISTRICT COURT
for the
EASTERN DISTRICT OF TEXAS

SINOTECHNIX, LLC	)	
<i>Plaintiff</i>	)	
v.	)	Civil Action No. 2:24-cv-00544-JRG-RSP
SAMSUNG ELECTRONICS CO., LTD.,	)	
et al.	)	
<i>Defendant</i>	)	

**SUBPOENA TO PRODUCE DOCUMENTS, INFORMATION, OR OBJECTS
OR TO PERMIT INSPECTION OF PREMISES IN A CIVIL ACTION**

To: SONY CORPORATION OF AMERICA - 25 Madison Ave, New York, NY 10010
c/o Corporation Trust Company, Corporation Trust Center, 1209 Orange St. Wilmington, DE 18901

(Name of person to whom this subpoena is directed)

☒ **Production: YOU ARE COMMANDED** to produce at the time, date, and place set forth below the following documents, electronically stored information, or objects, and to permit inspection, copying, testing, or sampling of the material: See Attachments A-C

Place: Transperfect One Gateway Center, 11-43 Raymond Plaza W, #620 Newark, NJ 07102	Date and Time: 02/20/2025 5:00 pm
--	--

☐ **Inspection of Premises: YOU ARE COMMANDED** to permit entry onto the designated premises, land, or other property possessed or controlled by you at the time, date, and location set forth below, so that the requesting party may inspect, measure, survey, photograph, test, or sample the property or any designated object or operation on it.

Place:	Date and Time:
--------	----------------

The following provisions of Fed. R. Civ. P. 45 are attached – Rule 45(c), relating to the place of compliance; Rule 45(d), relating to your protection as a person subject to a subpoena; and Rule 45(e) and (g), relating to your duty to respond to this subpoena and the potential consequences of not doing so.

Date: 02/11/2025

CLERK OF COURT

OR

_____ Signature of Clerk or Deputy Clerk	/s/ Lee J. Matalon Attorney's signature
---	--

The name, address, e-mail address, and telephone number of the attorney representing (name of party) _____
Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc., who issues or requests this subpoena, are:
Lee J. Matalon, Desmarais LLP - 230 Park Ave, New York, NY 10169 - (212) 808-2918 - LMatalon@DLLP.com

Notice to the person who issues or requests this subpoena

If this subpoena commands the production of documents, electronically stored information, or tangible things or the inspection of premises before trial, a notice and a copy of the subpoena must be served on each party in this case before it is served on the person to whom it is directed. Fed. R. Civ. P. 45(a)(4).

Civil Action No. 2:24-cv-00544-JRG-RSP

PROOF OF SERVICE

(This section should not be filed with the court unless required by Fed. R. Civ. P. 45.)

I received this subpoena for *(name of individual and title, if any)* _____
on *(date)* _____.

☐ I served the subpoena by delivering a copy to the named person as follows: _____

_____ on *(date)* _____; or

☐ I returned the subpoena unexecuted because: _____

Unless the subpoena was issued on behalf of the United States, or one of its officers or agents, I have also
tendered to the witness the fees for one day's attendance, and the mileage allowed by law, in the amount of
\$ _____.

My fees are \$ _____ for travel and \$ _____ for services, for a total of \$ _____ 0.00 _____.

I declare under penalty of perjury that this information is true.

Date: _____

Server's signature

Printed name and title

Server's address

Additional information regarding attempted service, etc.:

Federal Rule of Civil Procedure 45 (c), (d), (e), and (g) (Effective 12/1/13)

(c) Place of Compliance.

(1) For a Trial, Hearing, or Deposition. A subpoena may command a person to attend a trial, hearing, or deposition only as follows:

- (A) within 100 miles of where the person resides, is employed, or regularly transacts business in person; or
- (B) within the state where the person resides, is employed, or regularly transacts business in person, if the person
 - (i) is a party or a party's officer; or
 - (ii) is commanded to attend a trial and would not incur substantial expense.

(2) For Other Discovery. A subpoena may command:

- (A) production of documents, electronically stored information, or tangible things at a place within 100 miles of where the person resides, is employed, or regularly transacts business in person; and
- (B) inspection of premises at the premises to be inspected.

(d) Protecting a Person Subject to a Subpoena; Enforcement.

(1) Avoiding Undue Burden or Expense; Sanctions. A party or attorney responsible for issuing and serving a subpoena must take reasonable steps to avoid imposing undue burden or expense on a person subject to the subpoena. The court for the district where compliance is required must enforce this duty and impose an appropriate sanction—which may include lost earnings and reasonable attorney's fees—on a party or attorney who fails to comply.

(2) Command to Produce Materials or Permit Inspection.

(A) *Appearance Not Required.* A person commanded to produce documents, electronically stored information, or tangible things, or to permit the inspection of premises, need not appear in person at the place of production or inspection unless also commanded to appear for a deposition, hearing, or trial.

(B) *Objections.* A person commanded to produce documents or tangible things or to permit inspection may serve on the party or attorney designated in the subpoena a written objection to inspecting, copying, testing, or sampling any or all of the materials or to inspecting the premises—or to producing electronically stored information in the form or forms requested. The objection must be served before the earlier of the time specified for compliance or 14 days after the subpoena is served. If an objection is made, the following rules apply:

- (i) At any time, on notice to the commanded person, the serving party may move the court for the district where compliance is required for an order compelling production or inspection.
- (ii) These acts may be required only as directed in the order, and the order must protect a person who is neither a party nor a party's officer from significant expense resulting from compliance.

(3) Quashing or Modifying a Subpoena.

(A) *When Required.* On timely motion, the court for the district where compliance is required must quash or modify a subpoena that:

- (i) fails to allow a reasonable time to comply;
- (ii) requires a person to comply beyond the geographical limits specified in Rule 45(c);
- (iii) requires disclosure of privileged or other protected matter, if no exception or waiver applies; or
- (iv) subjects a person to undue burden.

(B) *When Permitted.* To protect a person subject to or affected by a subpoena, the court for the district where compliance is required may, on motion, quash or modify the subpoena if it requires:

- (i) disclosing a trade secret or other confidential research, development, or commercial information; or

(ii) disclosing an unretained expert's opinion or information that does not describe specific occurrences in dispute and results from the expert's study that was not requested by a party.

(C) *Specifying Conditions as an Alternative.* In the circumstances described in Rule 45(d)(3)(B), the court may, instead of quashing or modifying a subpoena, order appearance or production under specified conditions if the serving party:

- (i) shows a substantial need for the testimony or material that cannot be otherwise met without undue hardship; and
- (ii) ensures that the subpoenaed person will be reasonably compensated.

(e) Duties in Responding to a Subpoena.

(1) Producing Documents or Electronically Stored Information. These procedures apply to producing documents or electronically stored information:

(A) *Documents.* A person responding to a subpoena to produce documents must produce them as they are kept in the ordinary course of business or must organize and label them to correspond to the categories in the demand.

(B) *Form for Producing Electronically Stored Information Not Specified.* If a subpoena does not specify a form for producing electronically stored information, the person responding must produce it in a form or forms in which it is ordinarily maintained or in a reasonably usable form or forms.

(C) *Electronically Stored Information Produced in Only One Form.* The person responding need not produce the same electronically stored information in more than one form.

(D) *Inaccessible Electronically Stored Information.* The person responding need not provide discovery of electronically stored information from sources that the person identifies as not reasonably accessible because of undue burden or cost. On motion to compel discovery or for a protective order, the person responding must show that the information is not reasonably accessible because of undue burden or cost. If that showing is made, the court may nonetheless order discovery from such sources if the requesting party shows good cause, considering the limitations of Rule 26(b)(2)(C). The court may specify conditions for the discovery.

(2) Claiming Privilege or Protection.

(A) *Information Withheld.* A person withholding subpoenaed information under a claim that it is privileged or subject to protection as trial-preparation material must:

- (i) expressly make the claim; and
- (ii) describe the nature of the withheld documents, communications, or tangible things in a manner that, without revealing information itself privileged or protected, will enable the parties to assess the claim.

(B) *Information Produced.* If information produced in response to a subpoena is subject to a claim of privilege or of protection as trial-preparation material, the person making the claim may notify any party that received the information of the claim and the basis for it. After being notified, a party must promptly return, sequester, or destroy the specified information and any copies it has; must not use or disclose the information until the claim is resolved; must take reasonable steps to retrieve the information if the party disclosed it before being notified; and may promptly present the information under seal to the court for the district where compliance is required for a determination of the claim. The person who produced the information must preserve the information until the claim is resolved.

(g) Contempt.

The court for the district where compliance is required—and also, after a motion is transferred, the issuing court—may hold in contempt a person who, having been served, fails without adequate excuse to obey the subpoena or an order related to it.

UNITED STATES DISTRICT COURT

for the

EASTERN DISTRICT OF TEXAS

SINOTECHNIX, LLC

Plaintiff

v.

SAMSUNG ELECTRONICS CO., LTD.,

et al.

Defendant

Civil Action No. 2:24-cv-00544-JRG-RSP

SUBPOENA TO TESTIFY AT A DEPOSITION IN A CIVIL ACTION

To:

SONY CORPORATION OF AMERICA - 25 Madison Ave, New York, NY 10010
c/o Corporation Trust Company, Corporation Trust Center, 1209 Orange St. Wilmington, DE 18901

(Name of person to whom this subpoena is directed)

☒ **Testimony:** YOU ARE COMMANDED to appear at the time, date, and place set forth below to testify at a deposition to be taken in this civil action. If you are an organization, you must promptly confer in good faith with the party serving this subpoena about the following matters, or those set forth in an attachment, and you must designate one or more officers, directors, or managing agents, or designate other persons who consent to testify on your behalf about these matters: Documents and topics described in concurrent Subpoena to Produce Documents, Information or Objects

Place: Transperfect
One Gateway Center, 11-43 Raymond Plaza W, #620
Newark, NJ 07102

Date and Time:
02/27/2025 9:00 am

The deposition will be recorded by this method: Audio, Video, Stenographic

☐ **Production:** You, or your representatives, must also bring with you to the deposition the following documents, electronically stored information, or objects, and must permit inspection, copying, testing, or sampling of the material:

The following provisions of Fed. R. Civ. P. 45 are attached – Rule 45(c), relating to the place of compliance; Rule 45(d), relating to your protection as a person subject to a subpoena; and Rule 45(e) and (g), relating to your duty to respond to this subpoena and the potential consequences of not doing so.

Date: 02/11/2025

CLERK OF COURT

OR

/s/ Lee J. Matalon

Signature of Clerk or Deputy Clerk

Attorney's signature

The name, address, e-mail address, and telephone number of the attorney representing *(name of party)* Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc., who issues or requests this subpoena, are: Lee J. Matalon, Desmarais LLP - 230 Park Ave, New York, NY 10169 - (212) 808-2918 - LMatalon@DLLP.com

Notice to the person who issues or requests this subpoena

If this subpoena commands the production of documents, electronically stored information, or tangible things before trial, a notice and a copy of the subpoena must be served on each party in this case before it is served on the person to whom it is directed. Fed. R. Civ. P. 45(a)(4).

Civil Action No. 2:24-cv-00544-JRG-RSP

PROOF OF SERVICE

(This section should not be filed with the court unless required by Fed. R. Civ. P. 45.)

I received this subpoena for *(name of individual and title, if any)* _____
on *(date)* _____ .

☐ I served the subpoena by delivering a copy to the named individual as follows: _____

_____ on *(date)* _____ ; or

☐ I returned the subpoena unexecuted because: _____
_____ .

Unless the subpoena was issued on behalf of the United States, or one of its officers or agents, I have also
tendered to the witness the fees for one day's attendance, and the mileage allowed by law, in the amount of
\$ _____ .

My fees are \$ _____ for travel and \$ _____ for services, for a total of \$ 0.00 .

I declare under penalty of perjury that this information is true.

Date: _____

Server's signature

Printed name and title

Server's address

Additional information regarding attempted service, etc.:

Federal Rule of Civil Procedure 45 (c), (d), (e), and (g) (Effective 12/1/13)

(c) Place of Compliance.

(1) For a Trial, Hearing, or Deposition. A subpoena may command a person to attend a trial, hearing, or deposition only as follows:

- (A) within 100 miles of where the person resides, is employed, or regularly transacts business in person; or
- (B) within the state where the person resides, is employed, or regularly transacts business in person, if the person
 - (i) is a party or a party's officer; or
 - (ii) is commanded to attend a trial and would not incur substantial expense.

(2) For Other Discovery. A subpoena may command:

- (A) production of documents, electronically stored information, or tangible things at a place within 100 miles of where the person resides, is employed, or regularly transacts business in person; and
- (B) inspection of premises at the premises to be inspected.

(d) Protecting a Person Subject to a Subpoena; Enforcement.

(1) Avoiding Undue Burden or Expense; Sanctions. A party or attorney responsible for issuing and serving a subpoena must take reasonable steps to avoid imposing undue burden or expense on a person subject to the subpoena. The court for the district where compliance is required must enforce this duty and impose an appropriate sanction—which may include lost earnings and reasonable attorney's fees—on a party or attorney who fails to comply.

(2) Command to Produce Materials or Permit Inspection.

(A) *Appearance Not Required.* A person commanded to produce documents, electronically stored information, or tangible things, or to permit the inspection of premises, need not appear in person at the place of production or inspection unless also commanded to appear for a deposition, hearing, or trial.

(B) *Objections.* A person commanded to produce documents or tangible things or to permit inspection may serve on the party or attorney designated in the subpoena a written objection to inspecting, copying, testing, or sampling any or all of the materials or to inspecting the premises—or to producing electronically stored information in the form or forms requested. The objection must be served before the earlier of the time specified for compliance or 14 days after the subpoena is served. If an objection is made, the following rules apply:

- (i) At any time, on notice to the commanded person, the serving party may move the court for the district where compliance is required for an order compelling production or inspection.
- (ii) These acts may be required only as directed in the order, and the order must protect a person who is neither a party nor a party's officer from significant expense resulting from compliance.

(3) Quashing or Modifying a Subpoena.

(A) *When Required.* On timely motion, the court for the district where compliance is required must quash or modify a subpoena that:

- (i) fails to allow a reasonable time to comply;
 - (ii) requires a person to comply beyond the geographical limits specified in Rule 45(c);
 - (iii) requires disclosure of privileged or other protected matter, if no exception or waiver applies; or
 - (iv) subjects a person to undue burden.
- (B) *When Permitted.* To protect a person subject to or affected by a subpoena, the court for the district where compliance is required may, on motion, quash or modify the subpoena if it requires:

(i) disclosing a trade secret or other confidential research, development, or commercial information; or

(ii) disclosing an unretained expert's opinion or information that does not describe specific occurrences in dispute and results from the expert's study that was not requested by a party.

(C) *Specifying Conditions as an Alternative.* In the circumstances described in Rule 45(d)(3)(B), the court may, instead of quashing or modifying a subpoena, order appearance or production under specified conditions if the serving party:

- (i) shows a substantial need for the testimony or material that cannot be otherwise met without undue hardship; and
- (ii) ensures that the subpoenaed person will be reasonably compensated.

(e) Duties in Responding to a Subpoena.

(1) Producing Documents or Electronically Stored Information. These procedures apply to producing documents or electronically stored information:

(A) *Documents.* A person responding to a subpoena to produce documents must produce them as they are kept in the ordinary course of business or must organize and label them to correspond to the categories in the demand.

(B) *Form for Producing Electronically Stored Information Not Specified.* If a subpoena does not specify a form for producing electronically stored information, the person responding must produce it in a form or forms in which it is ordinarily maintained or in a reasonably usable form or forms.

(C) *Electronically Stored Information Produced in Only One Form.* The person responding need not produce the same electronically stored information in more than one form.

(D) *Inaccessible Electronically Stored Information.* The person responding need not provide discovery of electronically stored information from sources that the person identifies as not reasonably accessible because of undue burden or cost. On motion to compel discovery or for a protective order, the person responding must show that the information is not reasonably accessible because of undue burden or cost. If that showing is made, the court may nonetheless order discovery from such sources if the requesting party shows good cause, considering the limitations of Rule 26(b)(2)(C). The court may specify conditions for the discovery.

(2) Claiming Privilege or Protection.

(A) *Information Withheld.* A person withholding subpoenaed information under a claim that it is privileged or subject to protection as trial-preparation material must:

- (i) expressly make the claim; and
- (ii) describe the nature of the withheld documents, communications, or tangible things in a manner that, without revealing information itself privileged or protected, will enable the parties to assess the claim.

(B) *Information Produced.* If information produced in response to a subpoena is subject to a claim of privilege or of protection as trial-preparation material, the person making the claim may notify any party that received the information of the claim and the basis for it. After being notified, a party must promptly return, sequester, or destroy the specified information and any copies it has; must not use or disclose the information until the claim is resolved; must take reasonable steps to retrieve the information if the party disclosed it before being notified; and may promptly present the information under seal to the court for the district where compliance is required for a determination of the claim. The person who produced the information must preserve the information until the claim is resolved.

(g) Contempt.

The court for the district where compliance is required—and also, after a motion is transferred, the issuing court—may hold in contempt a person who, having been served, fails without adequate excuse to obey the subpoena or an order related to it.

Attachment A

Attachment A

Pursuant to Rules 34 and 45 of the Federal Rules of Civil Procedure, You are required to produce the documents requested below for inspection and copying. The requested documents are to be produced on or before February 20, 2025 at 5:00pm at Transperfect, One Gateway Center, 11-43 Raymond Plaza W, #620 Newark, NJ 07102 or at such other time and place as may be agreed by counsel. A copy of the Protective Order entered in this action for the protection of any requested proprietary, confidential, or commercially sensitive information is attached hereto as Attachment B.

DEFINITIONS AND INSTRUCTIONS

1. As used herein, “You” and “Your” means Sony Corporation of America, and all of its predecessors (merged, acquired, or otherwise), successors, subsidiaries, parents, sisters, divisions, departments, partnerships, and affiliates thereof, and all officers, directors, principals, agents, employees, attorneys, and other persons acting on its behalf.

2. As used herein, “Samsung” means Samsung Electronics Co. Ltd. and all of its predecessors (merged, acquired, or otherwise), successors, subsidiaries, parents, sisters, divisions, departments, partnerships, and affiliates thereof, and all officers, directors, principals, agents, employees, attorneys, and other persons acting on its behalf.

3. As used herein, “Seoul Semiconductor” means Seoul Semiconductor Co., Ltd. and its predecessor or successor entities, and any of its subsidiaries, divisions, affiliates, and any present and former agents, employees, partners, attorneys, representatives, and any other person or entity acting in concert with Seoul Semiconductor Co., Ltd., on behalf of Seoul Semiconductor Co., Ltd., or within the control of Seoul Semiconductor Co., Ltd, including, but not limited to, Seoul Optodevice Co. Ltd. and Seoul Viosys Co. Ltd.

4. As used herein, “Similar Product(s),” as applied to a product, means the identified product and any products having similar structure, function, and/or manufacturing process.

5. As used herein, “Related Publication(s),” as applied to a publication, means the identified publication and any publications concerning the same or related subject matter; and, as applied to a patent or patent application or publication, further includes all patents in the same family or otherwise sharing a priority relationship including provisionals, continuations, continuations-in-part, divisionals, and foreign counterparts.

6. As used herein, “Relevant Publication(s)” include the publications included in Attachment C; all publications (including patents and patent applications or publications in any jurisdiction) describing any Relevant Product(s) or Similar Products; and any Related Publication(s). See Attachment C.

7. As used herein, “Relevant Product(s)” refers to Sony Qualia 005, Triluminos, Sony PSP-1000, Sony DRU-700A, Sony KP-WS510, any products described in the Relevant Publications, and any Similar Products.

8. As used herein, “Relevant Date(s)” include October 7, 2004 and December 3, 2007.

9. As used herein, “and” and “or” shall be construed conjunctively and disjunctively, so as to acquire the broadest possible meaning.

10. As used herein, “any” and “all” shall be construed to mean “each and every,” so as to acquire the broadest possible meaning.

11. As used herein, “each” and “every” mean “each and every.”

12. As used herein, “include” and “including” shall be construed to mean “without limitation,” so as to acquire the broadest possible meaning.

13. As used herein, “document” has the same broad meaning as in Rule 34 of the Federal Rules of Civil Procedure. The term “document” also encompasses tangible things.

14. As used herein, “person” means any natural person or any business, legal, or governmental entity or association.

15. As used herein, “related” or “relating” to any given subject means, without limitation, identifying, describing, discussing, concerning, assessing, stating, reflecting, constituting, containing, embodying, tending to support or refute, or referring directly or indirectly to, in any way, the particular subject matter identified.

16. As used herein, “identify” as applied to an event means to provide a description of the event, the date of the event, the location of the event, and the individuals and entities participating in the event.

17. As used herein, the singular of any word shall include the plural, and the plural shall include the singular.

18. Pursuant to the requests herein, You are to produce any and all relevant documents within the Your possession, custody, or control, including documents located in the files of any and all of Your past and present association members, subsidiaries, parents, sisters, partnerships, directors, officers, agents, representatives, employees, attorneys, and accountants.

19. Produce each document in its entirety, without deletions, redactions, or exclusions, regardless of whether you deem part of a document outside of the scope of the requests.

20. Produce documents that identify the file or other source in which each document responsive to these requests is found or keep a record of such information.

21. Documents from any single file should be produced in the same order as they were found in such file, including any labels, files, folders, and/or containers in which such documents are located or with which such documents are associated. If copies of documents are produced in

lieu of the originals, such copies should be legible and bound or stapled in the same manner as the originals.

22. All documents that constitute electronically stored information, with that term having the meaning ascribed to it by the Federal Rules of Civil Procedure, shall be produced in an intelligible format.

23. If a document once existed, but has been lost, destroyed, erased, or otherwise is no longer in your possession, identify the document and state the details concerning the loss or destruction of such document, including the name and address of the present custodian of any such document known to You.

24. If, after conducting a reasonable investigation, a full answer cannot be provided for any request for the production of documents, state that such is the case and answer to the fullest extent possible, stating what responsive documents or information are available, what documents or information cannot be provided, and what efforts were made to obtain the unavailable documents or information.

25. If any of the documents requested herein are no longer in Your possession, custody, or control, identify for each such document the date, the type of the document, any senders and recipients, and any persons receiving any copies of each such document, and provide a summary of each such document's pertinent contents.

26. If any document responsive to these requests has been destroyed, describe the contents of the document, identify the location of any copies of the document, and the date of destruction of the document.

27. If any document is withheld on a claim of attorney/client privilege or work product immunity, provide a detailed privilege log that describes the nature and basis for your claim and

the subject matter of the document withheld, in a manner sufficient to disclose facts upon which You rely in asserting your claim and to identify the grounds and reasons for withholding the document. Such description should, at a minimum, include the date of the withheld document, an identification of each and every author of the document, an identification of each and every person who received the document, an identification of each and every person from whom the document was received, a description of the subject of the document, and further information relating to the document sufficient to explain the claim of privilege or immunity and to permit the adjudication of the propriety of that claim.

28. The document requests herein shall be deemed continuing, and it is requested that You provide supplemental responses and production as additional information or documents become available, in accordance with Rule 26(e) of the Federal Rules of Civil Procedure.

29. If a document is in a language other than English and an English translation exists, provide both documents.

DOCUMENT REQUESTS

1. All documents concerning the Relevant Product(s) and all Similar Products.
2. All Relevant Publication(s) and all Related Publications and documents concerning Relevant Publication(s) and Related Publications.
3. Documents sufficient to show public availability of the Relevant Publication(s) and all Related Publications prior to each Relevant Date.
4. Documents sufficient to show the structure, function, configuration, operation, material composition, manufacturing process, and supplier information for the Relevant Product(s) or any Similar Products prior to the Relevant Date(s).

5. Documents sufficient to show the structure and function of displays or display modules (including backlights) using the Relevant Product(s) or any Similar Products; including any diffusers, reflectors, LEDs or other light sources, light guides, LCD panels, and air gaps prior to the Relevant Date(s).

6. Documents sufficient to show the structure, function, configuration, operation, material composition, manufacturing process, and supplier information for all light-emitting diodes (LEDs) contained in the Relevant Product(s) or any Similar Products prior to the Relevant Date(s).

7. Documents sufficient to show the structure, function, configuration, operation, material composition, manufacturing process, and supplier information for all lenses contained in the Relevant Product(s) or any Similar Products prior to the Relevant Date(s).

8. Documents sufficient to show the package structure of Relevant Products or any Similar Products, including any lead frames, resins/encapsulants, LED chips, and phosphors (including type, number, placement, and emission spectra) prior to the Relevant Date(s).

9. Documents sufficient to show the manufacturing process for the Relevant Products including the forming of semiconductor layers, the photoresist process (including shape and dimensions), and any baking or etching processes (including temperatures) prior to the Relevant Date(s).

10. Documents sufficient to show the date on which each of the Relevant Product(s) or any Similar Products were first sold, on sale, offered for sale, in public use, or otherwise available to the public in the United States (including, for example, product catalogs, announcements, invoices, and sales records).

11. Physical samples of each Relevant Product and any Similar Products.

12. All documents describing any communication between You and Seoul Semiconductor relating to any of Your products with an LED or lens (including the Relevant Product(s) and any Similar Products) before the Relevant Date(s), including but not limited to any discussion, negotiation, and final agreement for the demonstration, exhibition, or sale of any such product to Seoul Semiconductor.

13. Documents sufficient to show Your policies for documenting and maintaining records in the ordinary course of Your business.

14. Documents sufficient to establish authenticity (within the meaning of Fed. R. Evid. 901) of each document You produce in response to this subpoena.

Attachment C

Attachment C-3

Technology of Wide Color Gamut Backlight with Light-Emitting Diode for Liquid Crystal Display Television

To cite this article: Koichiro Kakinuma 2006 *Jpn. J. Appl. Phys.* **45** 4330

View the [article online](#) for updates and enhancements.

You may also like

- [Color revolution: toward ultra-wide color gamut displays](#)
Zuoliang Wen, Ziming Zhou, Haochen Liu et al.
- [Narrow-band high-transmittance birefringent filter and its application in wide color gamut display](#)
Chi Zhang, , Rui Niu et al.
- [Critical Review—Narrow-Band Nitride Phosphors for Wide Color-Gamut White LED Backlighting](#)
Shuxing Li, Rong-Jun Xie, Takashi Takeda et al.



UNITED THROUGH SCIENCE & TECHNOLOGY

ECS The Electrochemical Society
Advancing solid state & electrochemical science & technology

**248th
ECS Meeting**
Chicago, IL
October 12-16, 2025
Hilton Chicago

**Science +
Technology +
YOU!**

**SUBMIT
ABSTRACTS by
March 28, 2025**

SUBMIT NOW

Technology of Wide Color Gamut Backlight with Light-Emitting Diode for Liquid Crystal Display Television

Koichiro KAKINUMA

*DBL Business Development Department, LCD Device Development Center, Core Component Business Unit, Sony Corporation,
1-11-1 Osaki, Shinagawa-ku, Tokyo 141-0032, Japan*

(Received July 28, 2005; accepted December 29, 2005; published online May 25, 2006)

The development of light-emitting diode (LED) backlight a wide-color-gamut and mercury-free has become active in liquid crystal display (LCD) industry. Reports on the development of backlights, such as a direct illumination-type back-light and a guided light illumination-type LED backlight were published. The fabrication of an actual commercial product has been progressing under this active development. Sony Corporation launched an LED-backlit LCD television (TV) model, dubbed QUALIA 005, the world's first home-use television featuring LED backlighting. This product offers a very wide color reproduction range, delivering a color gamut of 150% of that typically achieved by conventional televisions. In this paper, the background of the development of the LED backlight system "Triluminos™" and the technologies used to realize the wide color gamut are discussed. The main issues to be solved for the commercialization were how to reduce the brightness/color non uniformity of the backlight and how to treat heat generation from the LED. The standardization of wide color space definition xvYCC and LED backlight LCD television combination is expected to result in a more vivid and correct color expression, and a forecast that extends to the market in the future. [DOI: 10.1143/JJAP.45.4330]

KEYWORDS: wide color gamut, light-emitting diode (LED), liquid crystal display (LCD), color filter, brightness uniformity, color uniformity, thermal control

1. Introduction

The development of light-emitting diode (LED) backlight a wide-color-gamut and mercury-free has become active in liquid crystal display (LCD) industry. Reports on the development of backlights, such as a direct illumination-type back-light¹⁾ and a guided light illumination-type LED backlight²⁾ were published. Sony Corporation launched an LED-backlit LCD television (TV) model, dubbed QUALIA 005, the world's first home-use television featuring LED backlighting. "Create televisions that impress people by faithfully reproducing the colors of butterflies and flowers and all other beautiful colors on earth" are the dream not only the author but also Sony engineers that came true.³⁾ In the case of a liquid crystal display television, achieving color reproduction ranges exceeding far those available with conventional television sets requires a pure light source for a backlight system. To meet this challenge, we decided to employ red green blue (RGB) LED that provides the three primary colors independently. In a static approach to reducing brightness and color uniformities to levels appropriate for practical use, LED combinations and layouts are considered, whereas in a dynamic approach, electric compensation technology is utilized. This product offers a very wide color reproduction range, delivering a color gamut of 105% of the National Television Standards Committee (NTSC) color space, which indicates 150% of that typically achieved by conventional televisions (Fig. 1).

2. Color Gamut Achieved by the Triluminos™ LED Backlight System

The definition CIE x, y chromaticity diagram representing a color space is typically expressed two-dimensionally. However, because of the presence of a component in the brightness direction, such a diagram should be described as a three-dimensional cube in order to be evaluated accurately. As shown in Fig. 2, the Triluminos™ system not only offers expanded red and green color ranges but also delivers a

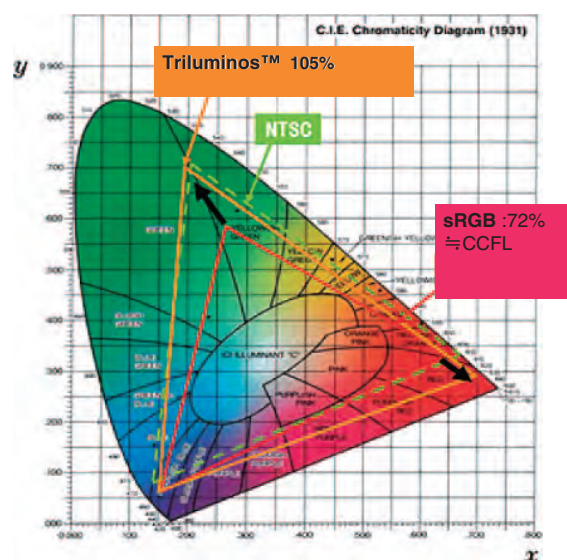


Fig. 1. The orange line indicates the LED backlit LCD television Triluminos color gamut.

sufficiently wider gamut than a conventional sRGB color space in the bright yellow and vivid orange regions that have high component values in the brightness direction. With LED lighting, even those colors expended in the brightness direction, such as that of the bright yellow flower shown in the photograph, can be represented faithfully.

To quantitatively assess these color spaces, an evaluation was conducted using a color chart created with a 768-color, high-chroma collection known as the Munsell Color Cascade or Pointer's Color⁴⁾ [Fig. 3(a)]. This color chart has a broader range of colors than the commonly used Macbeth Color Chart, and its color gamut is considered near the color limits of natural object surfaces. We used this color chart because we thought it would be desirable for television

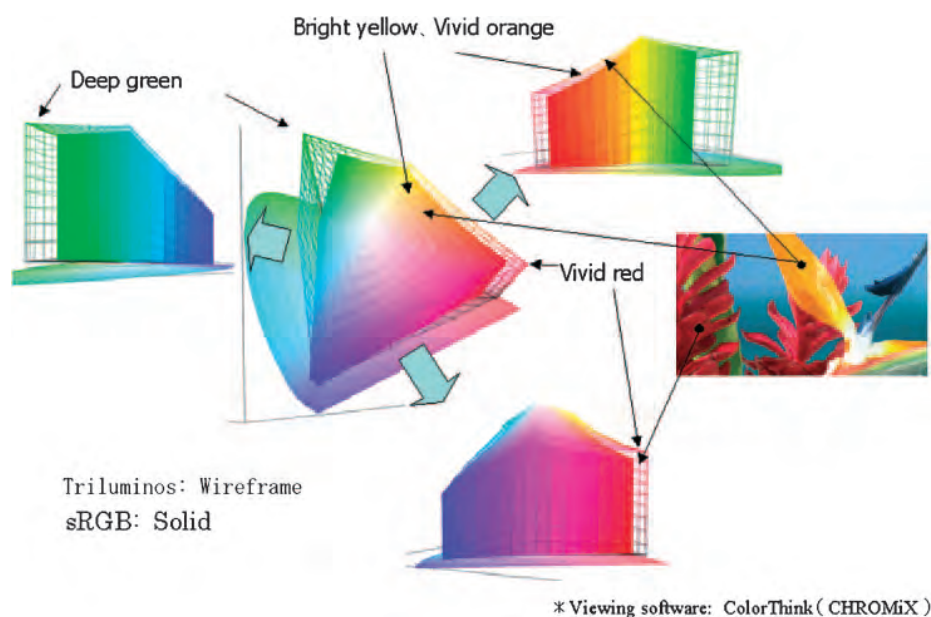


Fig. 2. Such a 3 D representation easily achieves wide color gamuts, such as those for deep green, bright yellow, and vivid red of the Triluminos.

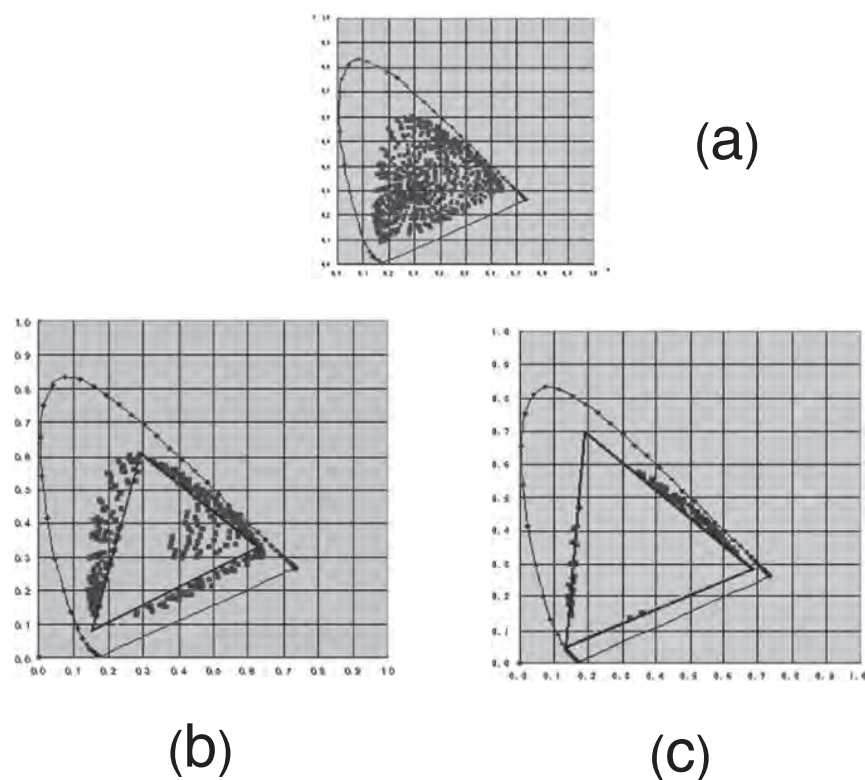


Fig. 3. The dotted point (a) shows the Pointer's color, which is used as the indicator of the system color gamut coverage. Dotted points are out of scale for the sRGB color gamut (b). This means that the sRGB color gamut covers 55% of the Pointer's color. The LED backlit Triluminos color gamut covers 82% of the Pointer's color (c).

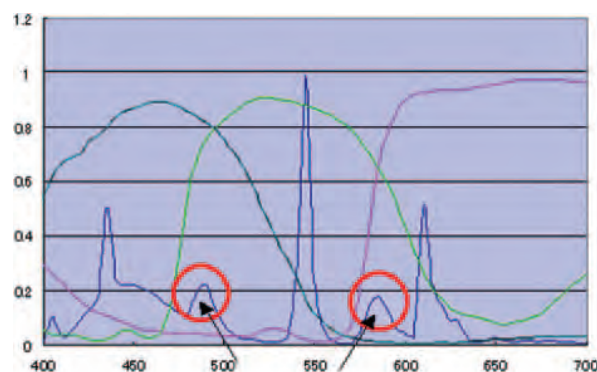
displays to have a color gamut that enables them to represent the color chart with as much color fidelity as possible.

A comparison of the percentage of the Pointer's Color chart covered by the display color gamut reveals that the percentage for the CRT television and cold cathode fluorescent lamp (CCFL) backlit liquid crystal display

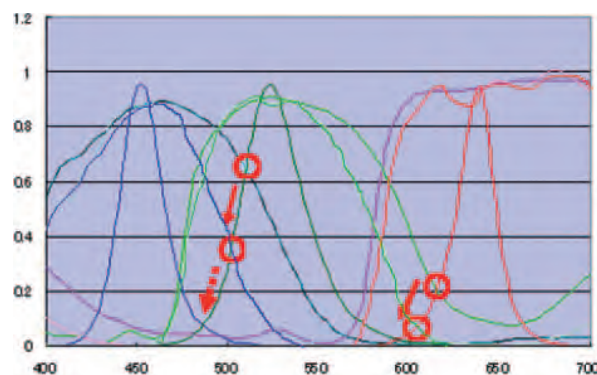
television sets is about 55% [Fig. 3(b)], while the LED-backlit liquid crystal display television set has a percentage higher 55%, which is about 82% [Fig. 3(c)].

3. Wide Color Gamut

The color gamut of a liquid crystal display is determined



(a)



(b)

Fig. 4. The CCFL light source has a number of impurity lines (a) in addition to the main emission line causing other lights to leak to the light of the originally intended wavelength, resulting in a poor color separation. We achieved a wide color gamut in LED backlight, reducing color leak by lowering the cross point (encircled) of the color filter and LED wavelength shown by the arrow in (b).

by the combination of the spectral characteristics of the backlight source and the spectral transmission factor of the color filter. For example, the CCFL light source widely used in liquid crystal displays has a number of impurity lines in addition to the main emission line because of the phosphor's properties. This causes other lights to leak to the light of the originally intended wavelength, resulting in a poor color separation [Fig. 4(a)]. With the LED light source, we have adopted, by contrast, separate spectrums formed for red, green, and blue, thus making it easier for the color filter to separate colors. To widen the color gamut, it is necessary not only to improve the characteristics of the light source but also to optimize the spectral transmission factor of the color filter so as to properly cover the spectral distribution of the light source. One effective method of accomplishing this is to prevent color leaks by lowering the cross point, where the spectral distribution curve of an individual LED intersects the spectral transmission factor curve of the color filter. In other words, the key is to prevent colors from leaking into adjacent colors [Fig. 4(b)].

Narrowing the wavelength bands of adjacent color filters or shifting the wavelength bands so as to avoid interference

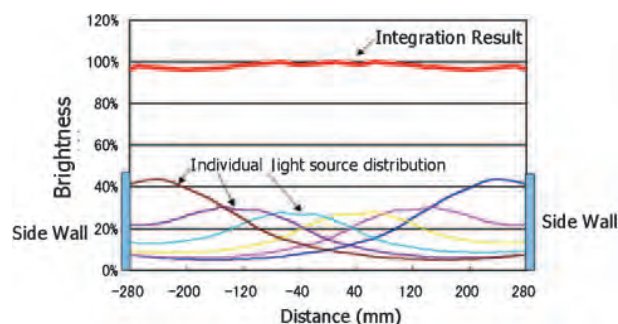


Fig. 5. Brightness integration result of individual light sources. Optimum row spacing for LED light source arrangement to make brightness flat.

is an effective approach to lowering the cross point. However, because a tremendous change in the spectral transmission factor of the color filter would lead to a low transmission and thus a low brightness, it is important to maintain the balance between the color gamut and brightness. When designing the product released last year, we attempted to lower the cross point for each color as much as possible while maintaining the proper level of brightness.

4. Brightness/Color Uniformity Control Technology

The key points to consider when commercializing a LED backlight are brightness, brightness uniformity, chromaticity uniformity, LED operating temperature, power consumption, service life, and cost. Increasing brightness requires that a sufficient number of LEDs be provided for each of the three colors; in particular, green has the highest sensitivity from a human luminosity curve. The necessary brightness ratio of RGB from a human luminosity curve is 3.3 : 10 : 1, whereas its given LED brightness ratio is 4 : 5 : 1. Therefore, the LED composition that meets the above-mentioned RGB brightness ratio from a human luminosity curve divided by the ratio of each LED brightness would be a four-element sequence with an RGB color ratio of 1 : 2 : 1. However, we adopted a five-element color sequence scheme, whereby one red LED is added with an RGB color ratio of 2 : 2 : 1, because the output of a red LED wildly varies depending on temperature.

The factors affecting brightness uniformity concerning the backlight as a whole are the spacing of LED rows and the distance from the side reflector. The luminous intensity distribution characteristic is determined using the relationship between the shape of the lens fitted to the top section of the LED, the size of the LED chip, and the wavelength in use. The spacing of LED rows is calculated using an optimum transfer function selected so that the synthesized distribution of brightness is uniform and flat, as shown in Fig. 5. In particular, the light emitted through the center of the lens forms a bird-eye-shaped region having a high brightness immediately above each LED. To curb such brightness uniformity, a transparent resin plate, called the diverter plate (Fig. 6) processed with a dot printing pattern, is placed between the LED and the diffuser to control part of the light flux emitted from the LED. This dot printing pattern is controlled by shape, density, and ink concentration, thereby contributing to reducing partial brightness uniformity without affecting the brightness level (Fig. 7).

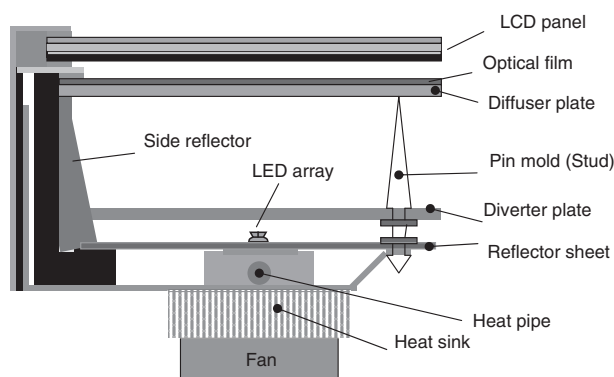


Fig. 6. The diverter plate which include dot printing patterns is placed between the LED and diffuser plate.

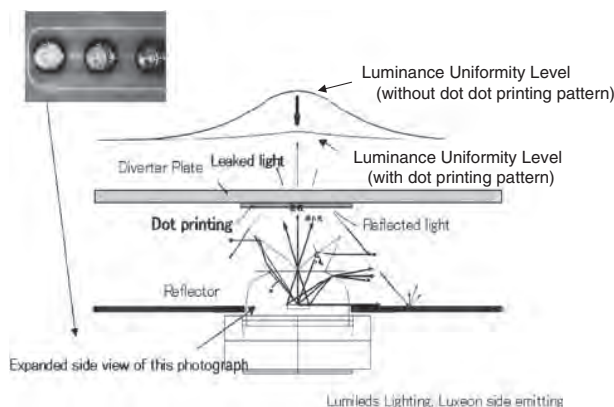


Fig. 7. Countermeasure for partial nonuniformity using a dot printing pattern. Processing with dot printing patterns eliminates partial brightness nonuniformity.

Measures are considered to stabilize brightness and chromaticity through the use of sensing and processing technologies. The brightness of an LED changes with time even when the LED is driven at a constant current. The causes of this change are temperature and time. To solve this problem, a mechanism is introduced, whereby the signals from the RGB color sensor are fed back to maintain brightness and chromaticity at given levels (Fig. 8). Through the appropriate arrangement of the LEDs of each color inside the backlight and the optimized design of the optical system consisting of the reflector and diffuser, the red, green, and blue LEDs are approximately mixed and chromaticity uniformity is provided. This enables changes in brightness and chromaticity to be detected by the color sensor attached to the side of the backlight.

Different control algorithms are used respectively for brightness changes due to a sudden change in temperature, such as that observed immediately after the power is turned on, and for temporal changes that occur slowly over a relatively long period of time. In the event of a huge, rapid change such as that observed upon turning on the power, an algorithm that sets large correction values based on the present temperature and brightness change ratio is set, so as to restore for consistency brightness and chromaticity to the target values quickly. A slow temporal change is resolved

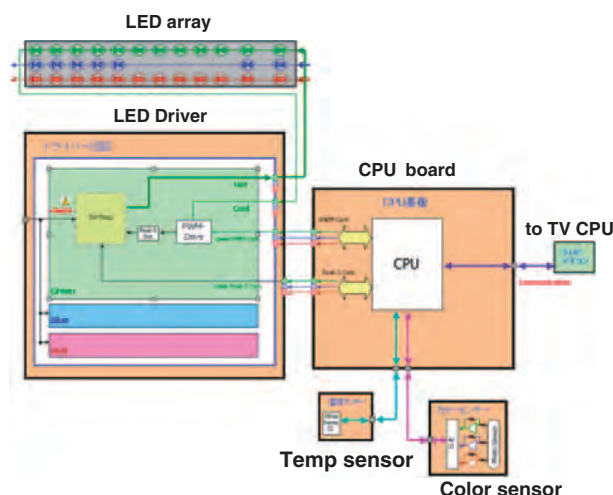


Fig. 8. A mechanism is introduced, whereby the signals from the RGB color sensor are fed back to keep brightness and chromaticity at given levels.

gradually by correcting the deviating values on a digit-by-digit basis with respect to the target brightness and chromaticity. Actually, we observed during the test that the color of the backlight is red immediately after turning on the power and then gradually changes to the target white color. This phenomenon was eliminated through the use of the algorithms described above.

5. Thermal Control Measures

There are three vital issues to consider in terms of heat design; how to transfer heat as high as 450 W in a 46 in. backlight, how to cool effectively with a limited area since many circuit boards should be mounted on the rear side of the backlight, and how to maintain tri color LEDs having different properties at a uniform temperature on the circuit board on which they are mounted. Repeated deliberations led us to an idea of installing cooling heat sinks on both sides of the backlight and mounting heat pipes horizontally on it, with the LED-generated heat equalized laterally by the heat pipes, while simultaneously transferring the heat to the heat sinks on both sides. The cooling system was designed based on this idea. The system has a cooling fan in the center of each heat sink, and the fan draws outside air and blows it through the apertures at the top and bottom of the heat sink. The use of this system offers a significant improvement in temperature uniformity in both the upper and lower parts of the backlight. Making maximum use of computer simulations allowed us to conduct all these deliberations concurrently with the designs of other parts of the backlight.

6. Conclusions

The QUALIA 005 television featuring the Triluminos™ LED backlight system is capable of reproducing various colors that are unreproducible with conventional televisions. In other words, a viewer can see those colors invisible on conventional television screens. It is now possible to deliver the colors that traditional televisions can by no means reproduce, such as the metallic green of the buprestid and Japanese gold beetles, the cyan of the Morpho butterfly, and

the deep red of a stained glass prone that is misrepresented as orange. This is what our veteran television engineers have been aspiring to achieve for decades.

7. Future Prospects

The color gamut of television has long been restricted by the limitations of hardware such as phosphor. However, the advent of an LCD television set equipped with an LED backlight has made it possible to offer a wide color gamut. In this situation, there is a call for a color space definition for a wide color gamut. The JEITA proposed a new standard, xvYCC, for international standardization to the International Electrotechnical Commission (IEC) in October 2004.⁵⁾ The xvYCC format offers full coverage of the 768-color Munsell Color Cascade chart mentioned earlier. Our understanding is that efforts to develop signaling systems that support a wide color gamut are going to accelerate in the coming years as hardware evolves toward color space standardization. We also expect the widespread use of LED backlights capable of reproducing colors that are unreproducible with conventional televisions in the future. In order for this to become a

reality, the LED needs to achieve a luminous efficiency comparable with that of the CCFL, thereby resolving the problems of power consumption and heat, and to approximate the CCFL in terms of the light source cost. We count on LED manufacturers to make rapid progress in this new area of technology.

Acknowledgements

I appreciate the support of Dr. Shigeo Kubota and my colleagues of Sony Corporation and Sony manufacturing systems in the development of this product. Special appreciation is extended to Lumileds Lighting, LLC and staff.

- 1) R. S. West: IDW'03, Fukuoka 2003, p. 657.
- 2) K. Kalantar and M. Okada: IDW'04, Niigata 2004, p. 683.
- 3) K. Kakinuma, T. Matsumoto, S. Haga, T. Arai, T. Shirakuma and H. Shibata: Nikkei Electronics (2004) Dec. 20, 123 [in Japanese].
- 4) M. R. Pointer: Color Res. Appl. **5** (1980) 145.
- 5) T. Kotani: Nikkei Electronics (2004) Dec. 20, 57 [in Japanese].