

1. For semiconductor product design, front and back-end manufacturers and microelectronics assemblers, and their suppliers and distributors:

a. Identify your company's role(s) in the semiconductor product supply chain.

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Nantero is the world leader in Carbon Nanotube (CNT)-based semiconductor technology, with locations in Woburn Massachusetts, Sunnyvale California, and Wilmington Delaware. We are the inventors, owners, designers and suppliers to market of the only American-based emerging memory technology, NRAM®. The current market-leading semiconductor memory technology, DRAM (Dynamic Random Access Memory), is widely understood to be nearing the end of its useful life, and Nantero's NRAM® (Non-Volatile Random Access Memory) is a highly-recognized emerging technology that is expected to disrupt and capture the memory market as the demand for better and faster memory technologies continue to grow.

Nantero is:

- (i) Designer - a product designer of Carbon Nanotube (CNT) Microelectronics with the largest portfolio and number of patents, i.e., 195 USA and 95 international patents for design, intellectual property, chemistry, etc. used by CNT (https://en.wikipedia.org/wiki/Carbon_nano-tube).
- (ii) Raw Materials Enhancer and Improved Materials Supplier – CNT microelectronics are chips/devices where traditional semiconducting material, silicon, has been replaced with semiconducting Carbon Nanotubes. Nantero has developed these materials and manufactures/tests/improves them in Woburn, MA, and then supplies these enhanced materials to customers (largest customers are two major Japanese companies, ZEON (https://www.jsr.co.jp/jsr_e/) and JSR (<https://www.zeonchemicals.com/>)). Nantero's process involves starting with raw carbon powder (known as "Carbon Black") and through a patented process these materials are turned into a fab-compatible CNT-slurry. With over 20 years in business and with over \$200 million invested, Nantero has successfully integrated these new, higher-performing materials into traditional silicon-based fab processes and equipment. Nantero also provides consulting services to companies seeking to add (or to make a full transition to) CNT-based microelectronics products to their portfolio.
- (iii) Chip Supplier – Nantero provides finished memory chips to the product supply chain in two ways: (1) supplying licensing agreements for Nantero Intellectual Property, Patents, and Trade Secrets to others for the purpose of developing finished CNT-based products within their development programs, and (2) by supplying Nantero NRAM chips directly to customers. In regard to direct sales, Nantero currently partners with customers to produce a custom-

designed CNT chip based on their needs, and through an agreed-upon Non-Recurring Engineering (NRE) process will develop a final chip design that is then purchased in bulk once performance standards are demonstrated by Nantero. Currently, our largest customer for custom NRAM chips is Fujitsu Semiconductor Manufacturing Company (Japan), with other well-known customers including Lockheed Martin, Schlumberger, Honeycomb Secure Systems and U.S. Federal Government (NASA & Intelligence Community).

Between 9/2016 - 1/2018 Nantero was engaged in an effort to evaluate Fab capabilities of the Semiconductor Manufacturing International Corporation (SMIC-PRC). SMIC demonstrated that it lacked the technical capacity to work for Nantero. As per PRC policy, in order for Nantero to enter into the aforementioned effort, Nantero was required to open an Office in Beijing. It has since been closed. Additionally, in 2017 Nantero took an investment from Shanghai Juyuanjuxin Semiconductor Industrial Equity Investment Fund Center, LP in the amount of \$5,000,000.00 (1.71% of the Company), as per our response to CFIUS then, that fund obtained no voting rights and/or any power of influence over the Company.

- b. Indicate the technology nodes (in nanometers), semiconductor material types, and device types that this organization is capable of providing (design and/or manufacture).

(1) Technology Nodes –

- a. NRAM has been produced, with chips available for inspection, at the following node sizes: 250, 180, 110, 90, 55, 45, 40, 28 nm
- b. NRAM physical and empirical models show that NRAM can be used in designs for the following node sizes: 22, 14, 12, 10, 7, 5, 3 nm

(2) Semiconductor Material Types-

- a. Nantero designs, improves, manufactures and supplies semiconducting Carbon Nanotube (CNT) materials with varying degrees of purity. CNT materials at the 70% purity level are ideal for memory-based applications, while CNT materials at the 99-100% purity level are ideal for Logic-based applications; Nantero is the world leader in supplying these materials to market (memory-based CNT materials are far more advanced than are logic-based materials within the current state of CNT materials science worldwide).

(3) Device Types -

- a. Nantero primarily supplies our uniquely designed Memory chips, known as NRAM®, to market consumers. We have varying finished chips available (as previously noted) at node sizes between 55-250 nm, with chips under development at sizes 22-45 nm with chips available for inspection.
- b. Within our portfolio of memory chips, we have the following chips types available: Crosspoint (XP), 1 Transmitter 1 Receiver (1T1R), and One Time Programmable (OTP).
- c. All of our NRAM memory chips are Non-Volatile. This is one of the primary features of NRAM® that makes it attractive and a recognized leading technology to replace DRAM.
- d. Nantero is currently developing a 512 GB Computer Express Link (CXL) device featuring 8Gb NRAM chips at 22nm node size. This device has the potential to disrupt Cloud and data center markets world-wide as servers powered with NRAM® will be faster,

smaller and require far less energy (and therefore, significantly reducing carbon emissions across these domains). Nantero is currently in exploratory talks with Intel Corporation regarding development of this chip and this device, and we are all very thankful for the potential funding within the US Innovation and Competition Act (USICA) that may enable us to keep this project on U.S. soil.

- e. Nantero's is also currently developing a 1G OTP chip, which in conjunction with our 55nm 1T1R Cadmus chip (currently at 5-sigma level on 300mm wafer coming out of USJC fab in Japan) will be our first widely commercialized embedded memory product (i.e., not just tailor-made for one unique customer, but widely available to a wide array of interested consumers for a variety of uses).
- f. Nantero does not dice nor package its own wafers, but we have several partners who accomplish these tasks.

- c. For any integrated circuits you produce—whether fabricated at your own facilities or elsewhere—identify the primary integrated circuit type, product type, relevant technology nodes (in nanometers), and actuals or estimates of annual sales for the years 2019, 2020, and 2021 based on anticipated end use.

Nantero 55nm NRAM microchips are currently undergoing qualification and certification review with Fujitsu Semiconductor Memory Solutions (Yokohama, Japan). Fujitsu's 5-SIGMA review will be complete 12/31/21. Nantero's Gen-one 55nm NRAM Memory aims to replace the existing Fujitsu ferroelectric Memory at that node size. Discussions with U.S. based fabricators aims to produce 22nm and 14nm NRAM within the next two years to meet market demand for Servers designed by Honeycomb Secure Systems, Inc (HSSi).

- d. For the semiconductor products that your organization sells, identify those with the largest order backlog. Then for the total and for each product, identify the product attributes, sales in the past month, and location of fabrication and package/assembly.

Nantero has been in discussions with HSSi regarding Servers it has designed that incorporate Nantero's NRAM. HSSi projects a need for over 25 million 22nm (Gen.-two) microchips per month (~30,000 wafer starts per month). Nantero and HSSi are in exploratory discussions with Intel Corporation to determine if it's processes can be used to fab Nantero chipsets. Should Nantero chip designs meet with Intel's Fabrication capabilities, building a relationship with Intel will satisfy a number of near-term requirements, particularly those related to packaging as Intel can do both. Relationships with other Fabrication companies will, by default, require that we send completed wafers elsewhere to be diced and packaged.

- i. List each product's top three current customers and the estimated percentage of that product's sales accounted for by each customer.

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- e. For each phase of the production process, identify whether your organization carries out the step internally or externally. For your organization's top semiconductor products, estimate each product's (a) 2019 lead time and (b) current lead time (in days), both overall and for each phase of the production process.

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Provide an explanation of any current delays or bottlenecks.

For an explanation of current delays or bottlenecks, see our response to Question 1. g. below next page.

- f. For your organization's top semiconductor products, list each product's typical and current inventory (in days), for finished product, in-progress product, and inbound product. Provide an explanation for any changes in inventory practices.

Not Applicable. Please see our response to 1.a.(i).

- g. What are the primary disruptions or bottlenecks that have affected your ability to provide products to

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- h. What is your organization's book-to-bill ratio for the past three years? Explain any changes.

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- i. If the demand for your products exceeds your capacity, what is the primary method by which your organization allocates the available supply?

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j. Does your organization have available capacity? If yes, what is preventing the filling of that capacity?

It has been our experience and as stated earlier in 1.a.(iii), we believe that at 70 liters per annum, Nantero has the available domestic capacity to meet the current requirements of the Department of Defense and a portion of the Critical Infrastructure sector. Should the need for CNT products in future years exceed that demand level, we will need to access additional capacity from the aforementioned foreign licensees, or preferably through U.S. Govt. investment in order to expand domestic capacity. An estimated \$600M to \$1B of USG funding will be needed to expand domestic raw material and slurry capacity.

Additionally, to achieve nearer-term process chemistry success, Nantero believes that it will be necessary to enlist the support of U.S. based chemical manufacturers whose technical expertise can be harnessed quickly to adopt Nantero's technology and meet ISO quality standards. Should Nantero undertake this mission on its own alone, the timeline required to bring capacity on-line and meet ISO requirements could add an additional year to such an undertaking.

k. Is your organization considering increasing its capacity? If yes, in what ways, over what timeframe, and what impediments exist to such an increase? What factors does your organization consider when evaluating whether to increase capacity?

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l. Has your organization changed its material and/or equipment purchasing levels or practices in the past three years?

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m. What single change (and to which portion of the supply chain) would most significantly increase your ability to supply semiconductor products in the next six months?

- Adoption of CNT technology by U.S. - based fabricators including Intel, Micron, Sky-Water, On-Semi, Texas Instruments, TSMC Arizona
- Creation and support of a CNT technology library including FETs, cells, arrays, controllers, etc. for fabricators and electronic design automation partners
- Standards for system interfaces to non-volatile memories, and adoption by CPU/GPU/MCU suppliers
- Improvements in die stacking including known good die testing.

<p>2. These next set of questions are not applicable for Nantero – Questions for intermediate users and end users of semiconductor products or integrated circuits:</p>
<p>a. Identify your type of business and the types of products you sell. N/A</p>
<p>b. What are the (general) applications for the semiconductor products and integrated circuits that you purchase? N/A</p>
<p>c. For the semiconductor products that your organization purchases, identify those that present the greatest challenge for your organization to acquire. Then for each product, identify the product attributes and purchases in 2019 and 2021, as well as average monthly orders in 2021. Then estimate the quantity of each product your organization would purchase in the next six months barring any production constraints as well as the amount your organization expects to actually be able to purchase. For each of your organization's top semiconductor products, estimate each product's lead times and your organization's inventory for (a) 2019 and (b) currently (in days). Provide an explanation of any current delays or bottlenecks. N/A</p>
<p>d. What are the primary disruptions or bottlenecks that have affected your ability to provide products to customers in the last year? N/A</p>
<p>e. Is your organization limiting production due to lack of available semiconductors? Explain. N/A</p>
<p>f. What percentage of your current production has your organization had to defer, delay, reject, or suspend in the past year? Explain. N/A</p>
<p>g. Is your organization considering or carrying out new investments to mitigate semiconductor sourcing difficulties? Explain. N/A</p>
<p>h. What semiconductor product types are most in short supply and by what estimated percentage relative to your demand? What is your view of the root cause? N/A</p>

i.	Has your organization changed its material and/or equipment purchasing levels or practices in the past three years? N/A
j.	What single change (and to which portion of the supply chain) would most significantly increase your ability to purchase semiconductors in the next six months? N/A
k.	What percentage of your orders are fulfilled by distributors versus through direct purchase orders to semiconductor product manufacturers? N/A
l.	For the semiconductor products your organization purchases, how long (in months) are the typical purchase commitments? How, if at all, do your organization's purchase commitments differ for products in short supply? N/A
m.	Has your organization faced "de-commits" (defined as a notification from a supplier that expected or committed supply will not be delivered in the agreed-upon time and quantity) in recent months? If this is a significant issue, please explain (e.g., nature of product, supplier, impact). N/A

FEDERAL REGISTER:

SUMMARY: The Department of Commerce (“Department”) (Bureau of Industry (“BIS”)) led the 100-Day Supply Chain Review of semiconductors and advanced packaging that was mandated by Presidential Executive Order. On February 24, 2021, President Biden issued an Executive Order on “America’s Supply Chains,” which directs several federal agency actions to secure and strengthen America’s supply chains. This review, included in the White House Report “Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth”, identified numerous areas of supply chain vulnerabilities.

The ongoing shortages in the semiconductor product supply chain are having an adverse impact on a wide range of industry sectors. With the goal of accelerating information flow across the various segments of the supply chain, identifying data gaps and bottlenecks in the supply chain, and potential inconsistent demand signals, the Department is seeking responses from interested parties (including domestic and foreign semiconductor design firms, semiconductor manufacturers, materials and equipment suppliers, as well as semiconductor intermediate and end-users) to the questions set forth in this notice.

DATES: The due date for filing comments is November 8, 2021.

ADDRESSES: Submissions: You may submit comments, identified by docket number BIS 2021–0036 or RIN 0694–XC084, through the Federal eRulemaking Portal: [http:// www.regulations.gov](http://www.regulations.gov). To submit comments via [https:// www.regulations.gov](https://www.regulations.gov), enter docket number BIS–2021–0036 on the home page and click “search.” The site will provide a search results page listing all documents associated with this docket. Find a reference to this notice and click on the link entitled “Comment Now!” (For further information on using <https://www.regulations.gov>, please consult the resources provided on the website by clicking on “How to Use This Site.”) BIS requires commenters submitting comments via [https:// www.regulations.gov](https://www.regulations.gov) to first download a fillable form from the BIS website at <https://bis.doc.gov/semiconductor> FRN2021 and to then submit the filled out electronic form in [https:// www.regulations.gov](https://www.regulations.gov) when submitting comments in response to docket number BIS 2021–0036 or RIN 0694–XC084.

FOR FURTHER INFORMATION CONTACT:

David Boylan, Defense Industrial Base Division, Office of Technology Evaluation, Bureau of Industry and Security, at 202–482–7816, SemiconductorStudy@bis.doc.gov.

SUPPLEMENTARY INFORMATION:

Background

BIS led the Department’s 100 Day Supply Chain Review of semiconductors and advanced packaging that was mandated by Presidential Executive Order (E.O.) 14017. On February 24, 2021, President Biden issued E.O. 14017 on “America’s Supply Chains,” which directs several federal agency actions to secure and strengthen America’s supply chains.

This review, included in the White House Report “Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad- Based Growth” (available at: <https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf>) (last accessed September 3, 2021), identified numerous areas of supply chain vulnerabilities. In addition to the longer-term goals such as strengthening the domestic semiconductor manufacturing ecosystem and promoting U.S. leadership, this report called upon the Department to partner with industry to facilitate information flow between semiconductor producers and suppliers and end-users to address the current semiconductor shortage. The ongoing shortage of semiconductor products is having an adverse impact on a wide range of industry sectors.

With the goal of facilitating the flow of information across the various segments of the supply chain, identifying data gaps and bottlenecks in the supply chain, and potential inconsistent demand signals, the Department is seeking responses from interested parties (including domestic and foreign semiconductor design firms, semiconductor and microelectronics manufacturers, materials and equipment suppliers, as well as semiconductor the questions set forth in this notice.

Information submitted in response to this request may contain business proprietary information, which will not be published and will be protected from disclosure, provided the submitters follow the instructions below for submitting confidential business information in the public comments.

Written Comments

Interested parties are invited to submit written comments, data, analyses, or information pertinent to this request to BIS’s Office of Technology Evaluation no later than November 8, 2021.

While the Department invites input from all interested parties, it is particularly interested in obtaining information from foreign and domestic entities that actively participate in the semiconductor product supply chain at any level (e.g., semiconductor design, front end semiconductor wafer fabrication, semiconductor assembly test and packaging, microelectronics assembly, intermediate and end-users of semiconductors and microelectronics, distributors of such products, as well as entities supporting semiconductor and microelectronics manufacturing as providers of materials and equipment). To allow for aggregation and comparison of data from multiple respondents, the Department has posted a fillable form on the BIS website that commenters must download and fill out for submission to <https://www.regulations.gov>. See the ADDRESSES section of this notice for where to find the fillable forms.

Requirements for Written Comments

The <https://www.regulations.gov> website allows users to provide comments by filling in a “Type Comment” field, or by attaching a document using an “Upload File” field.

As noted above, commenters will be required to use the BIS fillable form available on the BIS website when submitting comments in <https://www.regulations.gov>. The Department prefers that any additional comments be provided in a separate attached document. The Department prefers supplemental submissions in Microsoft Word (.doc files) or Adobe Acrobat (.pdf files). If the submission is in an application format other than Microsoft Word, Microsoft Excel, or Adobe Acrobat, please indicate the name of the application in the “Type Comment” field. Please do not attach separate cover letters to electronic submissions; rather, include any information that might appear in a

cover letter within the comments. Similarly, to the extent possible, please include any exhibits, annexes, or other attachments in the same file, so that the submission consists of one supplemental file instead of multiple additional files.

Comments (both public comments and non-confidential versions of comments containing business confidential information) will be placed in the docket and open to public inspection. Comments may be viewed on <https://www.regulations.gov> by entering docket number BIS-2021-0036 in the search. All filers should name their files using the name of the person or entity submitting the comments. Anonymous comments are also accepted. Communications from agencies of the United States Government will not be made available for public inspection.

Anyone submitting business confidential information should clearly identify the business confidential portion at the time of submission, file a statement justifying nondisclosure and referring to the specific legal authority claimed, and provide a non-confidential version of the submission. The BIS fillable form available on the BIS website referenced above will allow for an indication at the top of each page for whether it contains business confidential information. Users submitting a form that contains business confidential information, will need to submit a non-confidential version of the same form that does not contain the confidential business information. The non-confidential version of the submission will be placed in the public file on <https://www.regulations.gov>. For comments submitted electronically containing business confidential information, the file name of the business confidential version should begin with the characters "BC". Any page containing business confidential information must be clearly marked "BUSINESS CONFIDENTIAL" on the top of that page. The non-confidential version must be clearly marked "PUBLIC". The file name of the non-confidential version should begin with the character "P". The "BC" and "P" should be followed by the name of the person or entity submitting the comments or rebuttal comments. If a public hearing is held in support of this assessment, a separate **Federal Register** notice will be published providing the date and information about the hearing.

BIS does not maintain a separate public inspection facility. Requesters should first view the BIS's web page, which can be found at <https://efoia.bis.doc.gov/> (see "Electronic FOIA" heading). If requesters cannot access the website, they may call 202-482-0795 for assistance. The records related to this assessment are made accessible in accordance with the regulations published in part 4 of title 15 of the Code of Federal Regulations (15 CFR 4.1 through 4.11).

Matthew S. Borman,

Deputy Assistant Secretary for Export Administration.

[FR Doc. 2021-20348 Filed 9-23-21; 8:45 am]

BILLING CODE 3510-33-P