

## Do We Need A Roadmap?

*Perhaps the time has come for consensus-based planning within the compound semiconductor community to help ensure continuing growth as the industry matures.*

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Over the past four decades the silicon semiconductor industry has enjoyed a 15% compound annual growth rate. Such performance might be expected in emerging industries, but it is interesting to note that the silicon industry does not appear to be slowing as it matures. Many observers credit consensus-based planning and deliberate roadmapping efforts for the sustained growth of the silicon semiconductor industry over this past decade.

In the USA, the most important effort has been the National Technology Roadmap for Semiconductors (NTRS); it has been supplemented more recently by the International Technology Roadmap for Semiconductors (ITRS). These roadmaps have been an essential catalyst for the continued down-scaling of CMOS silicon technology, resulting in increased performance and lower cost.

Over the past five years we have witnessed the emergence of a compound semiconductor industry that is distinct from the silicon semiconductor industry. Given this fact, and the obvious success of consensus-based planning in the silicon arena, we wish to propose a question: Does the compound semiconductor industry need its own roadmap? And is the community ready to undertake the challenge of formulating an "International Technology Roadmap for Compound Semiconductors (ITRCS)"?

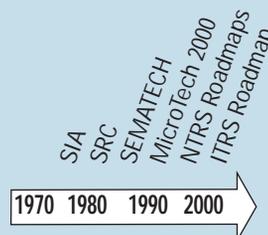
Segments of the compound semiconductor community are already considering the challenge seriously. From the historical perspective given in the sidebar, right, we are reminded that roadmap activities are already ongoing in the U.S. (NEMI) and Europe (MEL-ARI-OPTO) and in focused technology areas (OIDA). These may signify that the time is ripe for a more global roadmap initiative. After all, the major silicon roadmapping efforts of recent years were also preceded by smaller, scattered projects.

But of course, we must recall that there are important differences between the two technologies. Silicon is a large-volume consumer market focused on a narrow class of materials and devices, and based in large part on generic processes. Compound semiconductors were initially driven by defense funding, and even today, tend to require more fundamental research from university, industry and government laboratories. In part, this is because the materials base is very broad, and engineering approaches to process development within each materials system are not consistent. Nevertheless, the market is exploding with the wide variety of products. It should come as no surprise that opinions about the need for an ITRCS are almost as varied.

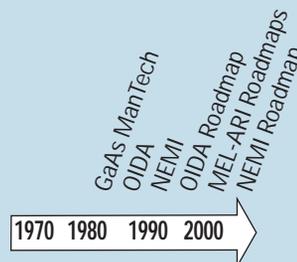
Our Metrology for Compound Semiconductor Manufacturing Project at the National Institute of Standards and

### Historical Events for Road-Mapping Activities

#### Silicon Semiconductors



#### Compound Semiconductors



### Relevant Roadmaps

- The Microelectronics Advanced Research Initiative Optoelectronics Technology Roadmap (MEL-ARI OPTO) is a European Commission effort in the area of III-V semiconductor interconnects for integrated circuits.

<http://europa.eu.int/>

- Roadmaps from the National Electronics Manufacturing Initiative (NEMI) treat numerous market applications, and have some specifically compound semiconductor-related content in the areas of energy storage and radio frequency devices, and optoelectronic integrated circuits components.

<http://www.nemi.org/>

- Roadmaps from the Optoelectronics Industry Development Association (OIDA) treat several diverse market applications and have some relevance to compound semiconductors in the areas of sensors, detectors, and displays.

<http://www.oida.org/>

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Technology (NIST) has been concerned with the roadmap issue for some time. Given the mission of our organization, our strategy for compound semiconductor planning highlights critical materials and fabrication technologies where infrastructure development, including standards, can have meaningful impact. Our need was acute for industry guidance in defining where, from the almost infinitude of technical avenues available, our expertise could best be focused.

In the absence of a formal ITRCS, the Pendragon Corporation conducted under contract to NIST an industrial survey within the U.S. to define requirements in the materials technology arena appropriate to our focused mission and limited resources<sup>[2]</sup>. From the inputs of 27 participants representing 15 industrial firms, 16 projects were selected as representative of the gaps most frequently cited within the wireless community. While the scope of our effort was necessarily

limited, we found that this exercise was profoundly positive and successful.

This experience has led us to conclude that other groups might receive similar benefits from focused roadmapping exercises. We speculate that the need might be much larger, more prevalent and generic, considering all of the work going on in industry, university and government laboratories. We invite the question: Is the compound semiconductor industry ready to undertake this challenge? If so, who will lead the charge? What resources are needed? Are they also available for continued refinements and updates of the first edition?

Responses to our inquiries to date span the extremes from "there is no need" to "the need is critical." We would like to invite more responses from the readers of this magazine. Accordingly, we have established a web-site for collecting and discussing ideas, comments and questions relating to the possible creation of ITRCS. Your thoughts are welcome, and can be posted at

<http://www.eeel.nist.gov/812/itrcs.html>.

As "food for thought", we are supplying a preliminary list of action items - see box.

The compound semiconductor industry at times seems quite fragmented, and some segments, especially in the USA, have a certain entrepreneurial character that may seem incompatible with the concept of consensus-based planning. So we conclude with the words of Dr. Avtar Oberai, formerly from IBM and a founding director of SEMATECH: "No one is big enough to drive the totality of the infrastructure and pre-competitive investments on their own." Oberai was a key player in bringing about collaborative planning for the silicon industry. The compound semiconductor industry has much to learn from his experiences and from others in the silicon industry.

**Submit your thoughts about roadmapping via the web at [www.eeel.nist.gov/812/itrcs.html](http://www.eeel.nist.gov/812/itrcs.html)**

### What are key actions needed to make progress towards an ITRCS?

- Assess which applications are most amenable - are there areas where companies consider it in their long-term financial interests to share intellectual property and capital?
- Identify which organizations will sponsor the development and maintenance of the proposed ITRCS.
- Convene workshops that bring together scientists, engineers, and managers concerned with strengthening the compound semiconductor infrastructure.

### What are metrics for assessing the impact of ITRCS?

With the diversity of opinions about how to proceed with ITRCS, how might we ultimately determine if it is worth the major investment? The investment itself, or financial outlay can be measured in a straightforward manner by monitoring expenditures, committee meetings and public relations and dissemination functions. However, methods by which to measure the impact the roadmap is having are more elusive. Meaningful metrics applied before the formation of ITRCS are very difficult to define. As with R&D organizations, the lagging-indicators appear more reliable. Several metrics are proposed which indicate leverage and buy-in from the technical and manufacturing communities:

- Growth of the compound semiconductor market relative to growth projected today, or to trends derived from historical performance
- The investment committed by industrial partners to roadmap workshops and activities
- Manufacturing yield enhancement related to allocation of corporate resources based on ITRCS guidelines
- The number of roadmap citations by university, industry and government expressed as a function of time

<sup>[2]</sup> D.L. Rode, "Compound Semiconductor Manufacturing: A Survey of Metrology and Related Technology Needs for the Compound Semiconductor Manufacturing Industry." This report is available from Pendragon Corporation, Nine The Prado, St. Louis, MO 63124.