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Dear IEEE History Committee,

It is my distinct pleasure and honor to write this letter with my most enthusiastic support of the IEEE Milestone Proposal, "Vertical-Cavity Surface-Emitting Laser, 1977" as an expert of this field.

Before proceeding with the review of the milestone proposal, please allow me to formally introduce myself and establish my credibility as a reviewer. I am Whinnery Chair Professor Emerita of EECS at the University of California, Berkeley, and Chairperson of Berxel Photonics, Inc. I was John R. Whinnery Chair Professor (2006-2020), Associate Dean for Strategic Alliances in the College of Engineering (2014-2019), and Chair of the Nanoscale Science and Engineering Graduate Group (2006-2017) at the same university. I was the Editor-in-Chief of Journal of Lightwave Technology 2007-2012. I was the President of Optica (formerly OSA) in 2021. I am a Fellow of IEEE, Optica, and IEE, and a member of the US National Academy of Engineering. My expertise lies in semiconductor lasers, particularly vertical-cavity surface -emitting lasers, and nano-photonics, with over 40 years of experience. I have received numerous prestigious scientific awards, including the 2024 Nick Holonyak Jr. Medal for Semiconductor Optoelectronic Technologies, the 2018 Okawa Prize, the 2017 Optica Nick Holonyak Jr. Award, and the 2011 IEEE David Sarnoff Award.

The following constitutes my review, addressing the questions posed by the IEEE History Committee.

1) Is the suggested wording of the Plaque Citation accurate?

The proposed plaque citation is appropriate, and the pioneering achievements are well-articulated.

In 1977, Kenichi Iga invented a groundbreaking semiconductor laser, namely the vertical cavity surface-emitting laser (VCSEL), and has continued to conduct pioneering research towards its realization in Tokyo Institute of Technology. The initial presentation of this concept occurred in March 1978, followed by the experimental realization of a current injection device in 1979. This was a significant breakthrough using a thin-film based VCSEL structure with a 6-micron cavity length. Following this and other foundational research efforts, his team achieved the first room-temperature continuous operation of a VCSEL in 1988, paving the way for many applications and commercialization in the three decades followed.

Another notable innovation was mechanical wavelength tuning through external mirror displacement in 1992. This work inspired my own work to invent a monolithic MEMS version in 1995, which enabled a broader wavelength tuning range of 15 nm. The widely tunable VCSEL is now utilized in Optical Coherence Tomography and 3D sensing.

2) Is the evidence presented in the proposal of sufficient substance and accuracy to support the Citation?

The submitted milestone proposal encompasses the extensive history from its inception to the early 2000s. Following the pioneering achievements at Tokyo Institute of Technology, numerous researchers and engineers have made contributions to this field. The evidence presented in the proposal is sufficiently substantial and accurate to support the citation. Furthermore, related and competing advancements have been thoroughly described.

3) Does the proposed milestone represent a significant technical achievement?

I would like to elucidate the impact and significance of the technical achievements outlined in the proposed milestone as an expert in VCSELs. Kenichi Iga's foresight encompassed three pivotal concepts. The first was the monolithic fabrication of laser cavities analogous to silicon-based LSIs. He envisioned constructing the cavity vertically on the surface of a semiconductor wafer, with light output extracted from the surface. The second major technical achievement was attaining single-wavelength operation even under high-speed modulation. Iga accomplished this by designing a laser cavity short enough to position one resonant mode within the gain spectrum. In 1982, he and his students realized a short cavity measuring less than 10 microns. Consequently, the laser cavity could take the form of a circular plate with a thickness of a few tens of microns and a diameter ranging from 2 to 20 microns, depending on the design. His team demonstrated the first room-temperature continuous-wave operation of a VCSEL in 1988, igniting explosive growth in VCSEL research. The third key contribution was involved making the resonant wavelength tunable, akin to quartz oscillators, achieved through wavelength tuning with an external mirror in 1992.

VCSELs have become indispensable for datacenter networks and 3D optical sensing. The VCSEL innovation spearheaded by Kenichi Iga facilitated optical parallel interconnects as the most cost-effective and high-performance solution for the next generation of very short-reach networks, significantly impacting supercomputers and datacenters. Additionally, VCSEL arrays have supported the development of compact spatial 3D ranging sensors. The adoption of VCSELs in sensing applications surged in 2017 when Apple Inc. integrated a 3D facial recognition sensor in the iPhone X, embedding hundreds of VCSELs in each device. Prior to this, I had demonstrated the foundational concept of triangulation light for depth sensing in 1998 using 940nm wavelength VCSEL arrays. In 2022 alone, more than 2.1 billion VCSEL units were deployed, making them the most widely used lasers globally, surpassing 10 billion devices of all types.

4) Do you think the name of Kenichi Iga deserves to be included in the word-count constrained Citation?

There is no doubt that Professor Iga's invention of VCSELs has given rise to significant new emerging technology and mass markets. He is widely recognized as the father of VCSELs globally. VCSELs have revolutionized optical data communications and optical interconnects. While numerous researchers and engineers have contributed to this field, Kenichi Iga stands out as a particularly distinguished pioneer. As evidence of his impact, Kenichi Iga received the 2021 IEEE Edison Medal and the 2024 Frederic Ives Medal/Jarus W. Quinn Prize from OPTICA. These accolades represent the highest honors conferred by IEEE and OPTICA, both of which boast more than 420,000 members worldwide.

5) Were there similar or competing achievements? If so, have the proposers adequately described these and their relationship to the achievement being proposed?

There is no one else comparable in scope or significance.

In summary, Professor Iga's work has made seminal contributions which created monumental impact and guided the developments of datacenter communications and 3D sensing industries. The proposed citation: "Vertical-Cavity Surface-Emitting Laser 1977-1992" is highly appropriate, with overwhelming evidence to support the citation. I provide this proposal with my strongest support. I strongly urge the Committee to consider his nomination favorably. Please do not hesitate to contact me if you need more information.

Yours sincerely,

Connie Chang-Hasnain