***THIS OPINION WAS NOT WRITTEN FOR PUBLICATION***

The opinion in support of the decision being entered today (1) was not written for publication in a law journal and (2) is not binding precedent of the Board.

Paper No. 13

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

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***Ex parte*** ALAN C. SEABAUGH, YUNG CHUNG KAO, ANDREW J. PURDES, and JOHN N. RANDALL

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Appeal No.1997-3695
Application No. 08/097,526

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ON BRIEF

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Before HAIRSTON, JERRY SMITH, and FLEMING, ***Administrative Patent Judges***.

FLEMING, ***Administrative Patent Judge***.

***DECISION ON APPEAL***

This is a decision on appeal from the rejection of claims 1 through 3. Claims 4 and 5 have been allowed.

Appellants' invention is generally directed to a method of forming quantum devices and in particular, to selective epitaxial deposition using an epitaxy mask formed by sidewall

defined masking. As disclosed on page 6 of the specification and Figs. 1 through 11, a thin conformal silicon dioxide glass layer 38 is formed over a patterned resist layer 36 having vertical sidewalls. An epitaxy mask is formed of the vertical sidewall portions of the glass layer after the horizontal portions of the glass layer and the resist are removed. The width of the epitaxy mask is the same as the thickness of the glass layer which allows selective epitaxy deposition on the exposed portions of the substrate defining gaps with smaller feature size than those achieved by an etching process. Additionally, Appellants on page 8 of the specification point out that after forming the laterally segmented epitaxial layers, the epitaxy mask is removed and a tunneling barrier layer is formed to fill the gaps left by the epitaxy mask.

Representative independent claim 1 is reproduced as follows:

> 1. A method of fabricating a quantum well device, said method comprising:
> forming an epitaxy mask by sidewall defined masking; and
> forming one or more quantized regions by selective deposition of one or more epitaxial layers.

The Examiner relies on the following references:

Nishida et al. (Nishida) 05-144732
Jun. 11, 1993
(Japanese)

Johnson, Jr., C., et al., *"Method for Making Submicron Dimensions in Structures Using Sidewall Image Transfer Techniques*." IBM Technical Disclosure Bulletin, Vol. 26, No. 9, pp. 4587-89
(Feb. 1984).

Galeuchet, Y.D., et al., "*In situ GalnAs/Inp quantum dot arrays by selective area metalorganic vapor phase epitaxy*." Applied Physics Letters 58(21), pp. 2423-25 (May 27, 1991).

Randall, J.N., et al., "*Electric field coupling to quantum dot diodes*." Journal of Vacuum Science and Technology, B9(6) pp. 2893-97 (Nov./Dec. 1991).

Claims 1 through 3 stand rejected under 35 U.S.C. § 103 as being obvious over Nishida, Galeuchet, Johnson, and Randall.

Rather than repeat the arguments of Appellants and the Examiner, reference is made to the brief and the answer for the details thereof.

***OPINION***

After careful review of the evidence before us, we do not agree with the Examiner that claims 1 through 3 are properly rejected under 35 U.S.C. § 103. Accordingly, we reverse.

The Examiner has failed to set forth a ***prima facie*** case. It is the burden of the Examiner to establish why one having ordinary skill in the art would have been led to the claimed invention by the express teachings or suggestions found in the prior art, or by implications contained in such teachings or suggestions. ***In re Sernaker***, 702 F.2d 989, 995, 217 USPQ 1, 6 (Fed. Cir. 1983). "Additionally, when determining obviousness, the claimed invention should be considered as a whole; there is no legally recognizable 'heart' of the invention." ***Para-Ordnance Mfg. v. SGS Importers Int'l, Inc***., 73 F.3d 1085, 1087, 37 USPQ2d 1237, 1239 (Fed. Cir. 1995), ***cert. denied***, 519 U.S. 822 (1996) ***citing W.L. Gore & Assoc., Inc. v. Garlock, Inc.***, 721 F.2d 1540, 1548, 220 USPQ 303, 309 (Fed. Cir. 1983), ***cert. denied***, 469 U.S. 851 (1984).

In regard to the rejection of claims 1 through 3 under 35 U.S.C. § 103, Appellants on page 3 of the brief argue that Johnson uses a sidewall mask of silicon nitride to etch the underlying polysilicon which differs from the patterning approach used by Nishida and Galeuchet. Appellants add that Nishida and Galeuchet use photoresist patterns to form quantum well sized openings in a silicon dioxide layer for selective

epitaxial growth. Appellants conclude that the references provide no basis or suggestion for combining Johnson with Nishida and Galeuchet. Additionally, Appellants on page 4 of the brief point out that Randall uses a metal mask for etching preexisting layers to form quantum dots separated by a 50-nm gap. Appellants further argue that Randall's process provides no suggestion to use the method of Johnson for selective epitaxial deposition of quantum wells laterally separated by a tunneling barrier.

The Examiner on page 5 of the answer responds to Appellants' arguments by stating that Nishida and Galeuchet use a silicon dioxide mask in an epitaxial deposition process where Johnson uses such mask in an etching process. The Examiner further states that one of ordinary skill in the art would have reasonably expected an etch mask to function as an epitaxial mask since both masks use the same material. The Examiner adds that Randall provided the motivation for such combination by teaching the desirability of fabricating closely spaced quantum devices.

As pointed out by our reviewing court, we must first determine the scope of the claim. "[T]he name of the game is

the claim." ***In re Hiniker Co.***, 150 F.3d 1362, 1369, 47 USPQ2d 1523, 1529 (Fed. Cir. 1998). Claims will be given their broadest reasonable interpretation consistent with the specification, and limitations appearing in the specification are not to be read into the claims. ***In re Etter***, 756 F.2d 852, 858, 225 USPQ 1, 5 (Fed. Cir. 1985).

We note that Appellants' claims 1 and 2 recite

> 1. ... forming an epitaxy mask by sidewall defined masking; and
> forming one or more quantized regions by selective deposition ...
>
> 2. ... forming an epitaxy mask on a crystalline substrate...;
> selectively depositing one or more epitaxial layers... to form a laterally segmented quantum well structure; and
> epitaxially depositing a tunneling barrier on said segmented quantum well structure [emphasis added].

We find that Appellants' claim 1 requires the step of forming an epitaxy mask that is made by sidewall defined masking as outlined by Appellants on page 3, lines 14 through 18 of the specification. The epitaxy mask is used for selective epitaxial deposition of the quantized regions having electron confinement layers. We note that during the step of selective epitaxial deposition, the sidewall epitaxy mask blocks the formation of epitaxial layer on the substrate where

the mask is present and allows the epitaxial layer to form only on the exposed portions of the substrate surface. Therefore, the selective deposition step, as recited in Appellants' independent claim 1, causes the gaps between the adjacent quantized regions to be defined by the width of the epitaxy mask. Appellants' independent claim 2 does not require sidewall masking and merely recites forming an epitaxy mask and selective deposition of a laterally segmented quantum well. However, we note that the recitation of "epitaxially depositing a tunneling barrier on the segmented quantum well[s]" in claim 2 requires small enough separation between quantum well segments that would allow the tunneling of electrons through the tunneling barrier.

The Federal Circuit states that "[t]he mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification." ***In re Fritch***, 972 F.2d 1260, 1266 n.14, 23 USPQ2d 1780, 1783-84 n.14 (Fed. Cir. 1992), ***citing In re Gordon***, 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984). It is further established that "[s]uch a suggestion may come from the nature

of the problem to be solved, leading inventors to look to references relating to possible solutions to that problem." ***Pro-Mold & Tool Co. v. Great Lakes Plastics, Inc***., 75 F.3d 1568, 1573, 37 USPQ2d 1626, 1630 (Fed. Cir. 1996), ***citing In re Rinehart***, 531 F.2d 1048, 1054, 189 USPQ 143, 149 (CCPA 1976) (considering the problem to be solved in a determination of obviousness). The Federal Circuit reasons in ***Para-Ordnance Mfg. Inc. v. SGS Importers Int'l Inc.***, 73 F.3d 1085, 1088-89, 37 USPQ2d 1237, 1239-40 (Fed. Cir. 1995), ***cert. denied***, 519 U.S. 822 (1996), that for the determination of obviousness, the court must answer whether one of ordinary skill in the art who sets out to solve the problem and who had before him in his workshop the prior art, would have been reasonably expected to use the solution that is claimed by the Appellants.

We find that both Nishida and Galeuchet a use selective epitaxial deposition method to form quantum dots in quantum dot sized openings etched in an epitaxy mask. Nishida and Galeuchet disclose conventional etching methods to form a small opening in the epitaxy mask where the quantum dot is to be formed rather than an epitaxy masking that provides a small

gap between the adjacent quantum well structures. Nishida on pages 8 and 9 teaches that an opening for the quantum device formation is etched in dielectric mask layer 12 using a photoresist mask. Nishida does not provide any teachings related to the separation of adjacent quantum device regions using a sidewall defined epitaxy mask. Galeuchet on page 2423, second col. and Fig. 1(b) discloses an array of 280 nm wide and 600 nm apart quantum dots which are selectively deposited in openings etched in an epitaxy mask layer. Turning to Johnson, we note that a sidewall mask for etching the gate layer is used to form a submicron gate structure. Johnson on page 4588 and Figs. 6 and 7 further teaches that sidewall mask 20 defines small gate feature in the underlying polysilicon layer 14 during an etch process. We further find that Randall teaches the formation of two quantum dot diodes for studying their operation under local electric field. Randall does not disclose any selective epitaxial deposition methods using an of epitaxy mask for forming the diode pair. Specifically, Randall on page 2894, section III. and Fig. 3 teaches that a diode pair is manufactured using self-aligned metal masking and etching techniques that leave small features

50 nm apart in existing multiple layers and form the diodes. Randall on page 2896, section V. further teaches that tunneling is present only in the vertical direction in each of the quantum dot diodes.

We do not agree with the Examiner that Johnson's sidewall mask may be combined with the epitaxy mask used in Nishida and Galeuchet to provide the step of "forming one or more quantized regions by selective deposition of one or more epitaxial layers" as recited in Appellants' claim 1. Johnson is concerned with etching small features using conventional lithography systems and uses the sidewall mask to etch the underlying layer except for a gate portion in the area covered by the mask. Therefore, Johnson's use of sidewall mask would have merely provided for a method of etching small features in the existing layers in Nishida and Galeuchet and not the epitaxy mask itself. Additionally, we find that Randall's diode pair is separated by
a gap of about 50 nm which does not allow electron tunneling through the gap as recited in Appellants' independent claim 2.

In view of the analysis above, we fail to find any reason or suggestion for combining Nishida and Galeuchet with Johnson

and Randall. We find that the Examiner has combined references containing the necessary pieces present in Appellant's claims 1 and 2 without any reason or motivation to combine. One of ordinary skill in the art would not have reasonably combined a reference providing a process of using a sidewall mask for etching existing underlying layers as taught by Johnson with the method of selective deposition of quantum dots inside the openings in epitaxy mask of Nishida and Galeuchet based on the suggestions of Randall which is directed to etching a pair of quantum dot diodes from existing layers. Therefore, we reverse the Examiner's rejection of claims 1 through 3 under 35 U.S.C.
§ 103 over Nishida, Galeuchet, Johnson, and Randall.

In view of the forgoing, the decision of the Examiner rejecting claims 1 through 3 under 35 U.S.C. § 103 is reversed.

***REVERSED***

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| KENNETH W. HAIRSTON<br>Administrative Patent Judge | ) | |
| JERRY SMITH<br>Administrative Patent Judge | ) | BOARD OF PATENT APPEALS AND INTERFERENCES |
| MICHAEL R. FLEMING<br>Administrative Patent Judge | ) | |

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