The opinion in support of the decision being entered today was not written for publication and is not binding precedent of the Board.

Paper No. 21

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte PETER D. GREENE,
MARK SILVER,
and ALFRED R. ADAMS

Appeal No. 1998-2938
Application 08/510,752[1]

ON BRIEF

Before BARRETT, FLEMING, and BLANKENSHIP, Administrative Patent Judges.

BARRETT, Administrative Patent Judge.

DECISION ON APPEAL

[1] Application for patent filed August 3, 1995, entitled "Polarisation-Insensitive Optical Modulators," which claims the foreign filing priority benefit under 35 U.S.C. § 119 of Great Britain Application 9415643.7, filed August 3, 1994.

This is a decision on appeal under 35 U.S.C. § 134 from the final rejection of claims 1-7.

We reverse.

BACKGROUND

The disclosed invention relates to a quantum confined Stark effect (QCSE)-based optical modulator which is polarization insensitive over a wide range of field strengths.

Claim 1, the sole independent claim, is reproduced below.

> 1. A quantum confined Stark effect modulator in which the or each quantum well layer of the modulator has a non-uniform composition that provides, across the thickness of the layer, a non-uniform value of lattice constant to produce a strain profile in the modulator that provides the modulator with substantially matching E1-HH1 and E1-LH1 Stark shifts for at least one polarity of applied electric field from 0 up to 100 kV/cm and zero field E1-LH1 and E1-HH1 transitions that are substantially degenerate.

The Examiner relies on the following prior art:

Zucker	5,090,790	February 25, 1992
Ishikawa et al. (Ishikawa)	5,153,687	October 6, 1992

Chen, W., and Andersson, T.G. (Chen), Quantum-confined Stark shift for differently shaped quantum wells, Semiconductor Science Technology 7 (1992), pp. 828-836.

Claims 1, 2, and 5 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Ishikawa and Zucker.

Claims 3, 4, 6, and 7 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Ishikawa and Zucker as applied to claims 1 and 5, further in view of Chen.

We refer to the Final Rejection (Paper No. 14) (pages referred to as "FR__") and the Examiner's Answer (Paper No. 20) (pages referred to as "EA__") for a statement of the Examiner's position, and to the Brief (Paper No. 19) (pages referred to as "Br__") for a statement of Appellants' arguments thereagainst.

OPINION

Content of Ishikawa and Zucker

Ishikawa discloses a quantum well structure constructed by gradually varying a mixture of AlGaAs (col. 3, lines 31-57) or by stacking layers of AlGaAs/AlAs of varying mixture ratios (col. 3, line 62 to col. 4, line 41) to produce a quantum confined potential that is symmetrical with respect to the center position of the quantum well plane and varies in proportion to the square of the distance from the center position, that is, in a curve of second degree as shown in figure 1. Ishikawa discloses that the respective shifts of the 1e-1lh and 1e-1hh transitions are substantially equal (col. 5, lines 60-66). As noted by the Examiner (FR2), Ishikawa does not teach a non-uniform lattice constant or strain profile. Appellants argue that the AlGaAs system is well known for the property that aluminum can be substituted for gallium with a negligible change of lattice constant, and hence a negligible effect on strain, and so Ishikawa is limited to structures having non-uniform composition but uniform lattice constant (Br5-6); this statement has not been challenged by the Examiner and is accepted as fact.

Zucker discloses a polarization independent electrooptical waveguide. The waveguiding region comprises one or more strained quantum well layers (col. 4, lines 44-46). Strain is introduced by changing the lattice constant and, therefore, the degree of lattice mismatch for a composition such as $In_xGa_{1-x}As$ by varying the mole fraction x (col. 5, lines 28-32). Lattice mismatching can be defined with respect to the substrate or with respect to any layer (col. 5, lines 44-47). Zucker discloses that the material combination GaAs/AlGaAs (the combination used in Ishikawa), among others, may be used instead of the GaAs/InGaAs composition discussed (col. 8, lines 17-28).

The rejection

The Examiner concludes (FR3):

> [I]t would have been obvious to use a GaAs/InGaAs system as disclosed in Zucker for the GaAs/AlGaAs system used in Ishikawa et al. because as taught in Zucker the two are equally interchangeable. In view of the modification, the quantum well layer would have a non-uniform lattice constant with accompanying strain profile and zero filed [sic, field] E1-LH1 and E1-HH1 transitions that are substantially degenerate.

Analysis

The two issues are whether the combination of Ishikawa and Zucker teaches or suggests (1) a quantum well substructure that "has a non-uniform composition that provides, across the thickness of the layer, a non-uniform value of lattice constant to produce a strain profile," and (2) a quantum well layer where the strain profile has the property of "substantially matching E1-HH1 and E1-LH1 Stark shifts for at least one polarity of applied electric field from 0 up to 100 kV/cm and zero field E1-LH1 and E1-HH1 transitions that are substantially degenerate."

(1)

Appellants argue that neither Ishikawa nor Zucker discloses a non-uniform lattice constant and, therefore, the combination of the two fails to include any suggestion of a structure with quantum wells having a non-uniform lattice constant (Br5).

The Examiner disagrees and states that the main objective of both Ishikawa and Zucker is a polarization insensitive semiconductor device, both teach varying the crystal mixture composition to attain this objective, and Zucker teaches that polarization independence can be achieved by mismatching of lattice constants (i.e., introducing strain) (EA5).

The Examiner does not answer the argument. Zucker discloses that polarization independence can be achieved by introducing strain in one or more quantum well layers, but does not disclose or suggest a quantum well layer with a non-uniform lattice constant or strain profile. Although Zucker discusses quantum well layers, plural, it does not disclose that a quantum well layer is composed of stacked layers of different materials (as in Ishikawa) having different strains. The strain is between a single layer and the substrate (col. 5, lines 12-14) or between the quantum well layer and a barrier layer (col. 5, lines 44-55). Thus, Zucker discloses a single quantum well layer with a uniform lattice constant (strain) and does not disclose or suggest a quantum well layer having a non-uniform lattice constant or strain profile across the thickness.

As we understand the Examiner's position, Zucker discloses materials that can be used to produce polarization independence by a quantum well layer that is lattice mismatched (strained) to the rest of the structure (the substrate or a barrier layer), Zucker teaches that equivalent structures can be implemented in other material systems including the materials in Ishikawa, and that substitution of strain inducing materials for the stacked layers of materials with constant lattice value in Ishikawa will inherently result in a quantum well layer with a non-uniform lattice constant. We disagree with this reasoning. Ishikawa and Zucker produce polarization independence in very different ways: Ishikawa by a non-uniform composition with constant lattice constant, and Zucker by a uniform composition having strain. There is no suggestion in Ishikawa of using stacked layers with mismatched lattice constants and there is no suggestion in Zucker to have more than one strained layer; i.e., neither Ishikawa nor Zucker discloses a quantum well layer with a non-uniform lattice constant and neither suggests a mix-and-match approach. As to the reasoning based on equivalence of the materials, Zucker teaches that different material systems could be used to produce a strained quantum well consistent with the teachings in Zucker, not in all quantum wells no matter how they are made. Further, Zucker discloses that the strain introduced by the lattice mismatch controls the resulting optical and electrooptical properties (col. 5, lines 32-37). This makes it questionable whether introducing strain in the non-uniform composition layers of Ishikawa would work. For these reasons, we conclude that the Examiner has failed to show the motivation necessary to establish a prima facie case of obviousness as to the limitation of a quantum well substructure that "has a non-uniform composition that provides, across the thickness of the layer, a non-uniform value of lattice constant to produce a strain profile."

It is not clear why the Examiner has gone to the trouble of trying to combine Ishikawa with Zucker to show a quantum well substructure with a non-uniform value of lattice constant when such a substructure is admitted to be known. In the Background to the Invention it is stated (specification, p. 2, lines 17-19): "[The Zhou paper] describes a strained quantum well with a graded composition providing a value of strain that is graded in magnitude from one side of the well to the other." Of course, there still remains the question of whether the quantum well layer strain profile has the property of "substantially matching E1-HH1 and E1-LH1 Stark shifts for at least one polarity of applied electric field from 0 up to 100 kV/cm and zero field E1-LH1 and E1-HH1 transitions that are substantially degenerate."

(2)

Appellants also argue that the claimed invention has the advantage of substantial polarization insensitivity over the range of applied field from 0 to 100 kV/cm because of matching E1-HH1 and E1-HH1 Stark shifts and that it is unclear to what extent, if at all, this matching occurs in Ishikawa (Br5; Br8-9). Appellants refer to figure 4 of Ishikawa as showing polarization insensitivity only for two values of applied field (Br9).

Although we have reversed the rejections, we will briefly discuss these arguments.

The Examiner states (EA5): "Ishikawa also clearly discloses the Stark shift over an applied electric field range of 0-100 kV/cm, as depicted in Figure 3(not Figure 4)." The Examiner points out that figure 3 corresponds to energy shifts according to the applied electric field (EA5-6).

We agree with the Examiner that Appellants' arguments regarding figure 4 appear misplaced since figure 4 does not show applied electric field. However, the Examiner's reasoning is of no help since it does not explain how figure 3 of Ishikawa shows "substantially matching E1-HH1 and E1-LH1

Stark shifts for at least one polarity of applied electric field from 0 up to 100 kV/cm and zero field E1-LH1 and E1-HH1 transitions that are substantially degenerate," as recited in claim 1. In the Final Rejection the Examiner stated that what constitutes "substantially matching" is not defined and that there appears to be little or no variability in figure 3 (FR6-7).

Appellants do not address the Examiner's arguments about "substantially" being a relative term. It appears that the term "substantially matching" may be defined in the specification because it is discussed (specification, p. 6, line 34 to p. 7, line 3): "The degree of residual mismatch between the two Stark shifts for positive fields [according to the invention] is computed as less than 1meV over the range from 0 to 100kV/cm. This compares with a separation of 6meV at a field of 100 kV/cm in respect of the Stark effect fields of Figure 3 in respect of quantum well possessing no substructure but strained to provide degeneracy at zero field strength." This has not been argued.

Nevertheless, figure 3 of Ishikawa is of no help in establishing the obviousness of the property of substantially matching Stark shifts. Assuming, arguendo, that it would have been obvious to substitute lattice mismatched materials for the layers in Ishikawa, it is certain that the curves in figure 3 are going to change in an unpredictable way. Thus, the only effective way to establish the property would be under the principle of inherency by finding a strained substructure as shown in Appellants' figures 2 and 5. Accordingly, we conclude that the Examiner has also failed to establish a prima facie case of obviousness as to the limitation of a quantum well layer where the strain profile has the property of "substantially matching E1-HH1 and E1-LH1 Stark shifts for at least one polarity of applied electric field from 0 up to 100 kV/cm and zero field E1-LH1 and E1-HH1 transitions that are substantially degenerate."

(3)

For the reasons stated above, the Examiner has failed to establish a prima facie case of obviousness over Ishikawa and Zucker. The rejection of claims 1, 2, and 5 is reversed. The Examiner has not pointed out how Chen would overcome the deficiencies of Ishikawa and Zucker. Thus, the rejection of claims 3, 4, 6, and 7 is also reversed.

REVERSED

LEE E. BARRETT Administrative Patent Judge	)	
MICHAEL R. FLEMING Administrative Patent Judge	)	BOARD OF PATENT APPEALS AND INTERFERENCES
HOWARD B. BLANKENSHIP Administrative Patent Judge	)	

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