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Tavkhelidze et al.

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#### (54) METHOD FOR MAKING A DIODE DEVICE

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### Related U.S. Application Data

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(51)	Int. Cl. <sup>7</sup>	 H01L 21/20

(52) **U.S. Cl.** ...... 438/380; 438/141; 438/328

## (56) References Cited

#### U.S. PATENT DOCUMENTS

3,740,592 A	6/1973	Engdahl et al.
4,011,582 A	3/1977	Cline et al.
4,063,965 A	12/1977	Cline et al.

5,336,547	Α	8/1994	Kawakita et al.
5,917,156	A	6/1999	Nobori et al.
6,214,651	B1	4/2001	Cox
6,225,205	<b>B</b> 1	5/2001	Kinoshita
6,417,060	B2	7/2002	Tavkhelidze et al.
2001/0046749	A1	11/2001	Tavkhelidze et al.
2003/0042819	A1 *	3/2003	Martinovsky et al 310/306
2003/0152815	A1 *	8/2003	LaFollette et al 429/7

#### FOREIGN PATENT DOCUMENTS

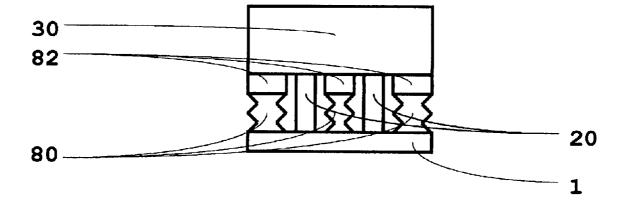
WO WO 99/13562 A1 3/1999

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#### (57) ABSTRACT

A method for manufacturing a pair of electrodes comprises fabricating a first electrode with a substantially flat surface and placing a sacrificial layer over a surface of the first electrode, wherein the sacrificial layer comprises a first material. A second material is placed over the sacrificial layer, wherein the second material comprises a material that is suitable for use as a second electrode. The sacrificial layer is removed with an etchant, wherein the etchant chemically reacts with the first material, and further wherein a region between the first electrode and the second electrode comprises a gap that is a distance of 50 nanometers or less, preferably  $\hat{5}$  nanometers or less. Alternatively, the sacrificial layer is removed by cooling the sandwich with liquid nitrogen, or alternatively still, the sacrificial layer is removed by heating the sacrificial layer, thereby evaporating the sacrificial layer.

# 7 Claims, 5 Drawing Sheets



<sup>\*</sup> cited by examiner