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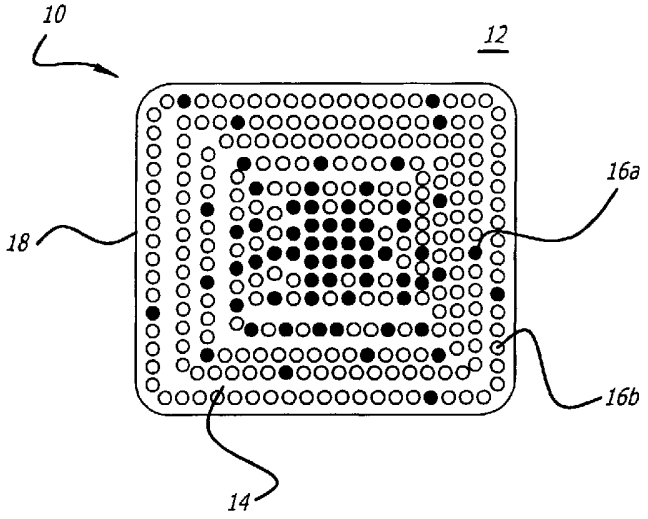
(54) Title: SOLID-STATE LASER DEVICES WITH RADIAL DOPANT VALENCE PROFILE



(57) Abstract: A solid state, laser light control device (20, 30) and material (10), and methods of producing same. The device (20, 30) and material (10) consist essentially of a host material (14) which contains: a dopant species (16) at a first valence state (a), the concentration of which increases with distance from the surface (18); and the same dopant species (16) at a second valence state (b), the concentration which decreases with distance from the surface (18). The method comprises the steps of: obtaining a doped solid state material (14); exposing the solid state material (14) to elevated temperature, for a period of time, in an oxidizing or reducing atmosphere. The elevated temperature and time of exposure are selected to change the valence state (a) of the dopant (16) in direct proportion to distance from the surface (18) of the solid state material (16). What is thereby produced is a solid state device (20, 30) in which the concentration of the dopant 16 at the second valence state (b) decreases with radius, the concentration of the dopant (16) at the first valence state (a) increases with radius, and the sum of these concentrations remains constant.

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01S3/16 H01S3/113 H01S3/0941 C30B33/00 C30B31/00
G02F1/35

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 761 233 A (BRUESSELBACH HANS ET AL) 2 June 1998 (1998-06-02) cited in the application the whole document	1
A	US 4 833 333 A (RAND STEPHEN C) 23 May 1989 (1989-05-23) cited in the application the whole document	1
A	US 4 824 598 A (STOKOWSKI STANLEY E) 25 April 1989 (1989-04-25) column 4, line 5 - line 12	1

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Hervé, D

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	NOGAMI M ET AL: "SM2+-DOPED SILICATE GLASSES PREPARED BY A SOL-GEL PROCESS" APPLIED PHYSICS LETTERS, AMERICAN INSTITUTE OF PHYSICS. NEW YORK, US, vol. 65, no. 10, 5 September 1994 (1994-09-05), pages 1227-1229, XP000464611 ISSN: 0003-6951 page 1228, column 1, line 3 - line 15	1
A	MORINAGA K ET AL: "Compositional dependence of the valency state of Cr ions in oxide glasses" JOURNAL OF NON-CRYSTALLINE SOLIDS, NORTH-HOLLAND PHYSICS PUBLISHING. AMSTERDAM, NL, vol. 220, no. 2-3, 1 November 1997 (1997-11-01), pages 139-146, XP004100595 ISSN: 0022-3093 the whole document	1
A	FR 2 339 266 A (COMMISSARIAT ENERGIE ATOMIQUE) 19 August 1977 (1977-08-19) the whole document	1

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 03/10721

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5761233 A	02-06-1998	EP 0801449 A2	15-10-1997
		JP 10027930 A	27-01-1998
		NO 971587 A	13-10-1997
US 4833333 A	23-05-1989	DE 3874716 D1	22-10-1992
		DE 3874716 T2	22-04-1993
		EP 0324017 A1	19-07-1989
		IL 86755 A	25-05-1992
		JP 2500706 T	08-03-1990
		WO 8900777 A1	26-01-1989
US 4824598 A	25-04-1989	NONE	
FR 2339266 A	19-08-1977	FR 2339266 A1	19-08-1977