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(54) **SELECTIVE LIGHT ABSORBING SEMICONDUCTOR SURFACE**

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See application file for complete search history.

(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.
4,039,352 A 8/1977 Marinescu
4,063,965 A 12/1977 Cline et al.
4,686,162 A 8/1987 Stangl et al.
5,023,671 A 6/1991 DiVincenzo et al.
5,068,535 A 11/1991 Rabalais
5,119,151 A 6/1992 Onda
(Continued)

FOREIGN PATENT DOCUMENTS

DE 3404137 A1 8/1985
(Continued)

OTHER PUBLICATIONS

Oxford English Dictionary online, Second Edition, 1989.*
(Continued)

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(57) **ABSTRACT**

A selective light absorbing semiconductor surface is disclosed. Said semiconductor surface is characterized by the presence of indentations or protrusions comprising a grating of dimensions such as to enhance the absorption of selected frequencies of radiation. In a preferred embodiment of the present invention, said grating is formed on the surface of a doped semiconductor for the purposes of optical frequency down conversion. The semiconductor is doped so as to create energy levels within the forbidden zone between the conduction and valence bands. Incident radiation excites electrons from the valence to conduction band from where they decay to the meta-stable newly created energy level in the forbidden zone. From there, electrons return to the valence band, accompanied by the emission of radiation of lower frequency than that of the incident radiation. Optical frequency down-conversion is thus efficiently and rapidly accomplished. In a further embodiment of the present invention said grating is formed on the entrance and exit surfaces of one or more layers of a single or multi-junction solar cell. In this embodiment said grating is characterized by indents of depth $\lambda/4$ and width $>\lambda$, where $\lambda$ is the wavelength of solar radiation incident on the layer under consideration.

**17 Claims, 3 Drawing Sheets**