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Bhattacharya

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(54) **ELECTRODEPOSITION OF GALLIUM FOR PHOTOVOLTAICS**

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CPC .. ***C25D 3/54*** (2013.01); ***C25D 5/10*** (2013.01); ***C25D 5/50*** (2013.01); ***C25D 5/54*** (2013.01); ***H01L 31/0322*** (2013.01); ***H01L 31/0747*** (2013.01); *C25D 7/126* (2013.01); *Y02E 10/541* (2013.01); *Y02P 70/521* (2015.11)

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USPC 205/224, 227, 261, 157, 159, 162, 170, 205/182

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,063,172	A	5/2000	Bokisa et al.
7,507,321	B2	3/2009	Aksu et al.

(Continued)

FOREIGN PATENT DOCUMENTS

WO	2009032021	3/2009
WO	2009061984	5/2009

(Continued)

OTHER PUBLICATIONS

Steichen et al., "Controlled Electrodeposition of Cu—Ga from a Deep Eutectic Solvent for Low Cost Fabrication of CuGaSe2 Thin Film Solar Cells," Phys. Chem. Chem. Phys. (no month, 2011), vol. 13, pp. 4292-4302.*

(Continued)

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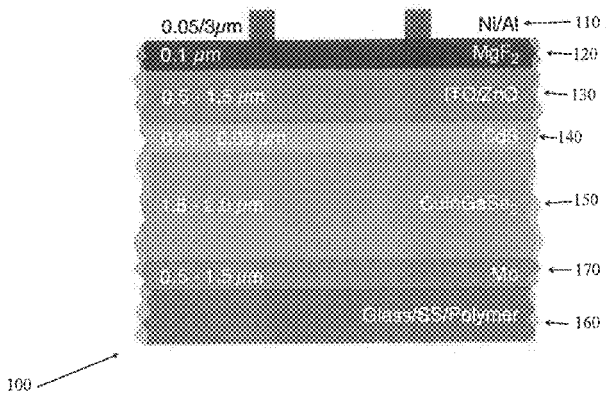
(57) **ABSTRACT**

An electroplating solution and method for producing an electroplating solution containing a gallium salt, an ionic compound and a solvent that results in a gallium thin film that can be deposited on a substrate.

16 Claims, 7 Drawing Sheets