



(12) **United States Patent**  
**Lowenthal et al.**

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(54) **BIDIRECTIONAL LIGHTING APPARATUS WITH LIGHT EMITTING DIODES**

H01L 25/0753; H01L 33/22; H01L 33/58; H01L 33/50; F21K 9/56

See application file for complete search history.

(71) Applicant: **NthDegree Technologies Worldwide Inc.**, Tempe, AZ (US)

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(72) Inventors: **Mark David Lowenthal**, Gilbert, AZ (US); **William Johnstone Ray**, Fountain Hills, AZ (US); **Neil O. Shotton**, Tempe, AZ (US); **Richard A. Blanchard**, Los Altos Hills, CA (US); **Brad Oraw**, Mesa, AZ (US); **Mark Allan Lewandowski**, North Port, FL (US); **Jeffrey Baldrige**, Chandler, AZ (US); **Eric Anthony Perozziello**, Discovery Bay, CA (US)

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(73) Assignee: **NthDegree Technologies Worldwide Inc.**, Tempe, AZ (US)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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CPC . **F21V 23/06** (2013.01); **F21K 9/56** (2013.01);

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(58) **Field of Classification Search**

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*Primary Examiner* — Joseph L Williams

(74) *Attorney, Agent, or Firm* — Nancy R. Gamburd; Gamburd Law Group LLC

(57) **ABSTRACT**

An exemplary printable composition of a liquid or gel suspension of diodes comprises a plurality of diodes, a first solvent and/or a viscosity modifier. An exemplary apparatus comprises: a plurality of diodes; at least a trace amount of a first solvent; and a polymeric or resin film at least partially surrounding each diode of the plurality of diodes. Various exemplary diodes have a lateral dimension between about 10 to 50 microns and about 5 to 25 microns in height. Other embodiments may also include a plurality of substantially chemically inert particles having a range of sizes between about 10 to about 50 microns.

**21 Claims, 97 Drawing Sheets**

