



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

|                                                                                                                                                                                                                                                                                                                                                                                |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| (51) International Patent Classification <sup>6</sup> :<br><b>B05D 3/00, 5/12, H01M 4/32, 4/34, 4/36, 4/44, 4/48, 4/54, 4/58</b>                                                                                                                                                                                                                                               |  | A1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | (11) International Publication Number: <b>WO 00/10736</b>           |
|                                                                                                                                                                                                                                                                                                                                                                                |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | (43) International Publication Date: <b>2 March 2000 (02.03.00)</b> |
| (21) International Application Number: <b>PCT/US98/25088</b>                                                                                                                                                                                                                                                                                                                   |  | (81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). |                                                                     |
| (22) International Filing Date: <b>24 November 1998 (24.11.98)</b>                                                                                                                                                                                                                                                                                                             |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                     |
| (30) Priority Data:<br><b>60/097,706</b> <b>21 August 1998 (21.08.98)</b> <b>US</b>                                                                                                                                                                                                                                                                                            |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                     |
| (71) Applicant (for all designated States except US): <b>SRI INTERNATIONAL [US/US]; 333 Ravenswood Avenue, Menlo Park, CA 94025 (US).</b>                                                                                                                                                                                                                                      |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                     |
| (72) Inventors; and<br>(75) Inventors/Applicants (for US only): <b>NARANG, Subhash [US/US]; 333 Ravenswood Avenue, Menlo Park, CA 94025 (US). SHARMA, Sunity [IN/US]; 333 Ravenswood Avenue, Menlo Park, CA 94025 (US). COX, Philip [GB/US]; 333 Ravenswood Avenue, Menlo Park, CA 94025 (US). VENTURA, Susanna [IT/US]; 333 Ravenswood Avenue, Menlo Park, CA 94025 (US).</b> |  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                     |
| (74) Agent: <b>FISH, Robert, D.; Crockett &amp; Fish, Suite 706, 1440 N. Harbor Boulevard, Fullerton, CA 92835 (US).</b>                                                                                                                                                                                                                                                       |  | Published<br>With international search report.<br>With amended claims.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                     |

(54) Title: **PRINTING OF ELECTRONIC CIRCUITS AND COMPONENTS**

(57) Abstract

Methods are disclosed for printing (2-7) multilayer electronic components, and circuits on a surface (2), where at least one of the layers is formed by a redox reaction (6) occurring in a deposited solution (4, 5). Electronic components may comprise semiconductors such as in transistors or diode, or metal oxide or electrolyte such as in batteries or fuel cells, or are capacitors, inductors, and resistors. Preferably, the oxidizer of the redox reaction is a strong oxidizer, and the reducer is a strong reducer (3). Reactions are preferably sufficiently exothermic that they can be initiated (6), rather than driven to completion, by microwave or other suitable energy sources, and may yield substantially pure metal or metal oxide layers. The solution being deposited (5) may have either high concentrations of particulates, such as 60-80 wt.% of dry weight, or low concentrations of particulates, such as ≤5 wt.% or ≤2 wt.%. Low particulate content provides printing of structures having lateral resolution of ≤10 μm, ≤5 μm, or ≤1 μm.

```

graph TD
    2[Providing A Surface] --> 3[Providing A Redox Couple]
    3 --> 4[Solubilizing At Least One Of The Redox Couple Constituents In The Solution]
    4 --> 5[Transferring The Solution To The Surface]
    5 --> 6[Initiating A Redox Reaction]
    6 --> 7[Completing The Component By Adding At Least One Additional Layer]
  
```