



(51) **International Patent Classification:**
C25B 1/02 (2006.01) **H05H 3/02** (2006.01)
H05H 1/24 (2006.01)

[CA/CA]; 90 Jennifer Road, London, Ontario N5X 3K6 (CA).

(21) **International Application Number:**
PCT/CA2010/000299

(74) **Agent:** **HILL & SCHUMACHER**; 264 Avenue Road, Toronto, Ontario M4V 2G7 (CA).

(22) **International Filing Date:**
3 March 2010 (03.03.2010)

(81) **Designated States** (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(25) **Filing Language:** English

(26) **Publication Language:** English

(30) **Priority Data:**
61/202,477 3 March 2009 (03.03.2009) US

(71) **Applicant** (for all designated States except US): **THE UNIVERSITY OF WESTERN ONTARIO** [CA/CA]; 1151 Richmond Street North, Stevenson-Lawson Building, Room 319, London, Ontario N6A 5B8 (CA).

(72) **Inventors; and**

(75) **Inventors/Applicants** (for US only): **LAU, Leo W. M.** [CA/CA]; 701 Hillcrest Drive, London, Ontario N6K 1A8 (CA). **YANG, De-Quan** [CA/CA]; 461 Platt's Lane, Apt. 33, London, Ontario N6G 3H2 (CA). **TREBICKY, Tomas** [CA/CA]; 140 Cherryhill Place, Apt. 705, London, Ontario N6H 4M5 (CA). **NIE, Heng Yong**

(84) **Designated States** (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) **Title:** METHOD FOR PRODUCING HYPERTHERMAL HYDROGEN MOLECULES AND USING SAME FOR SELECTIVELY BREAKING C-H AND/OR Si-H BONDS OF MOLECULES AT OR ON SUBSTRATE SURFACES

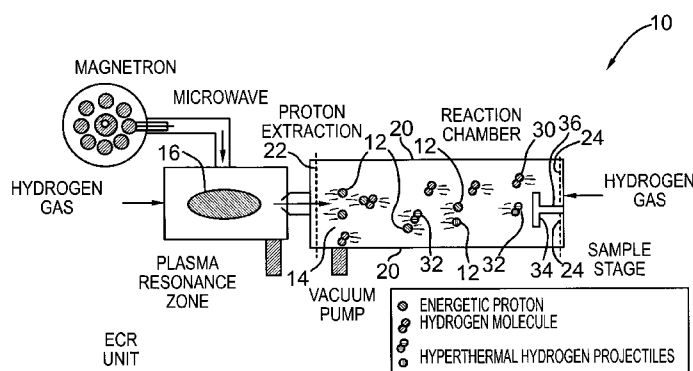


FIGURE 2

(57) **Abstract:** A method for producing hyperthermal molecular hydrogen is disclosed and use of same for selectively breaking C-H or Si-H bonds without breaking other bonds are disclosed. A hydrogen plasma is maintained and protons are extracted with an electric field to accelerate them to an appropriate kinetic energy. The protons enter into a drift zone to collide with molecular hydrogen in gas phase. The cascades of collisions produce a high flux of hyperthermal molecular hydrogen with a flux many times larger than the flux of protons extracted from the hydrogen plasma. The nominal flux ratio of hyperthermal molecular hydrogen to proton is controlled by the hydrogen pressure in the drift zone, and by the length of the drift zone. The extraction energy of the protons is shared by these hyperthermal molecules so that average energy of the hyperthermal molecular hydrogen is controlled by extraction energy of the protons and the nominal flux ratio. Since the hyperthermal molecular hydrogen projectiles do not carry any electrical charge, the flux of hyperthermal hydrogen can be used to engineer surface modification of both electrical insulating products and conductive products. When this method of generating a high flux of hyperthermal molecular hydrogen is applied to bombard organic precursor molecules (or silicone, or silane molecules)

[Continued on next page]

**Published:**

— with international search report (Art. 21(3))

— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

with desirable chemical functionality/functionalities on a substrate, the C-H or Si-H bonds are thus cleaved preferentially due to the kinematic selectivity of energy deposition from the hyperthermal hydrogen projectiles to the hydrogen atoms in the precursor molecules. The induced cross-linking reactions produce a stable molecular layer having a controllable degree of cross-linking and retaining the desirable chemical functionality/functionalities of the precursor molecules.