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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
02 October 2025 (02.10.2025)

WIPO | PCT

(10) International Publication Number
WO 2025/207230 A1

(51) International Patent Classification:
H01L 21/66 (2006.01) *G01B 15/00* (2006.01)
H01L 23/544 (2006.01)

(21) International Application Number:
PCT/US2025/016036

(22) International Filing Date:
14 February 2025 (14.02.2025)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
18/620,463 28 March 2024 (28.03.2024) US

(71) Applicant: **TOKYO ELECTRON LIMITED** [JP/JP]; 3-1 Akasaka 5-chome, Minato-ku, Tokyo, 107-6325 (JP).

(71) Applicant *(for JP only)*: **TOKYO ELECTRON U.S. HOLDINGS, INC.** [US/US]; 401 S 1st St, Suite 900, Austin, Texas 78704 (US).

(72) Inventors: **MACHUCA, Francisco**; 2859 Bayview Dr., Fremont, California 94538 (US). **TIAN, Xinkang**; 2859 Bayview Dr., Fremont, California 94538 (US). **ZHANG, Shuyan**; 2859 Bayview Dr., Fremont, California 94538 (US).

(74) Agent: **STRANG, Eric**; Tokyo Electron U.S. Holdings, Inc., 401 S 1st St, Suite 900, Austin, Texas 78704 (US).

(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, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UY, UZ, VC, VN, WS, ZA, ZM, ZW.

WO 2025/207230 A1

(54) Title: X-RAY METHODS AND SYSTEMS FOR SEMICONDUCTOR SUBSTRATE ALIGNMENT

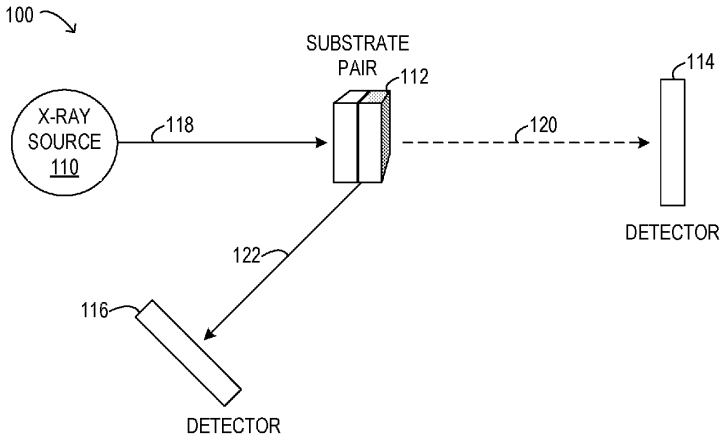

FIG. 1

(57) Abstract: X-rays are directed to a first substrate and to a second substrate in a bonding configuration for bonding together. The X-rays are directed to first and third alignment marks in the first substrate and to second and fourth alignment marks in the second substrate. Fluorescent X-rays are detected upon emission from the first alignment mark and the second alignment mark to measure a first misalignment of the first substrate with respect to the second substrate based on a first detected misalignment of the first and second alignment marks. X-rays transmitted through the first and second substrates using X-ray Talbot-Lau interferometry to measure a second misalignment of the first and second substrates based on a second detected misalignment of the third and fourth alignment marks.

[Continued on next page]

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

Published:

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