



- (51) **International Patent Classification:**
Not classified
- (21) **International Application Number:**
PCT/SG2023/050177
- (22) **International Filing Date:**
17 March 2023 (17.03.2023)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
10202202742X 18 March 2022 (18.03.2022) SG
- (71) **Applicant: NATIONAL UNIVERSITY OF SINGAPORE** [SG/SG]; 21 Lower Kent Ridge Road, Singapore 119077 (SG).
- (72) **Inventors: WANG, Wei David;** c/o National University of Singapore, Centre for Additive Manufacturing, 21 Lower Kent Ridge Road, Singapore 119077 (SG). **SOH, Sin Liang;** c/o National University of Singapore Faculty of Engineering, Department of Mechanical Engineering, 21 Lower Kent Ridge Road, Singapore 119077 (SG). **LU, Wen Feng;** c/o National University of Singapore Faculty of Engineering, Department of Mechanical Engineering, 21 Lower Kent Ridge Road, Singapore 119077 (SG). **LAW, Matthew Lee Liang;** c/o National University of Singapore Faculty

of Engineering, Department of Mechanical Engineering, 21 Lower Kent Ridge Road, Singapore 119077 (SG). **LEE, Poh Seng;** c/o National University of Singapore Faculty of Engineering, Department of Mechanical Engineering, 21 Lower Kent Ridge Road, Singapore 119077 (SG).

(74) **Agent: TAY, Yeo King;** 151 Chin Swee Rd, #12-14 Manhattan House, Singapore 169876 (SG).

(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, UZ, VC, VN, WS, ZA, ZM, ZW.

(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,

(54) **Title:** HYBRID 3D PRINTED HEAT SINK

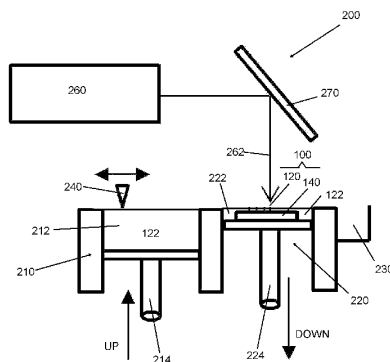


FIG. 10

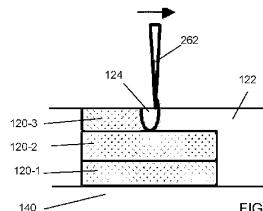


FIG. 11

(57) **Abstract:** The present invention describes heat sinks (100) in which fins (120) are hybrid 3D printed using laser powder-bed fusing (LPBF) or selective laser melting (SLM) (200) of a fin powder (122) deposited directly over a substrate (140). The fin powder (122) forms a powder-bed, which height is increased, layer by layer, and the fins (120) are being built up, layer by layer, by laser melting and fusing the fin powder (122). The fin powder (122) may be copper, copper alloy, aluminium or aluminium alloy, whilst the associated substrate (140) is copper-based or aluminium-based. The substrate (140) is prepared by conventional machining, hence, the process (200) is called hybrid LPBF or SLM. The heat sinks (100) obtained have excellent heat dissipation and temperature stability performances.

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).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *without international search report and to be republished
upon receipt of that report (Rule 48.2(g))*