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CLAIMS

1. A method of determining optimal values of one or more process parameters for printing a part by additive manufacturing, the part having a design, the method comprising
5 steps of:
 - (i) obtaining a plurality of sets of test values for the one or more process parameters;
 - (ii) causing an additive manufacturing system to at least partially generate a plurality of test samples according to the design and the plurality of sets of test values;
 - 10 (iii) obtaining, during or after generation of the plurality of test samples, test data indicative of respective measurements of at least one property of the test samples for respective sets of test values;
 - (iv) fitting the test data to a second-order function that relates the at least one property to the one or more process parameters to determine coefficients of the one or more
15 process parameters; and
 - (v) determining, based on the second-order function and the coefficients, optimal values for the one or more process parameters that result in a global optimum for the at least one property.
- 20 2. A method according to claim 1, wherein the method is performed for a single batch of raw material.
3. A method according to claim 1 or claim 2, wherein step (ii) comprises partially generating one of the test samples, and step (iii) comprises obtaining test data for the partially
25 generated test sample, such that the global optimum is obtained prior to completion of generation of the test sample.
4. A method according to claim 3, wherein partially generating one of the test samples comprises printing one layer or a few layers of the test sample; and obtaining test data
30 comprises measuring a temperature distribution of the partially generated test sample.

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5. The method of any one of the preceding claims, wherein the plurality of test samples are generated at different respective times.
6. The method of any one of the preceding claims, wherein the at least one property comprises one or more of: porosity, residual stress, mechanical properties, surface properties, electronic or magnetic related properties.
7. The method of claim 6, wherein the mechanical properties comprise one or more of: yield stress and compressive stress; and/or wherein the surface properties comprise surface roughness.
8. The method of any one of the preceding claims, wherein the at least one process parameter includes one or more of: laser power, scanning speed, powder-bed temperature, hatch distance, layer thickness, post processing heat treatment time, and temperature.
9. The method of any one of the preceding claims, wherein the optimal values are determined using a 3D surface plot.
10. The method of any one of the preceding claims, wherein the additive manufacturing system is powder based.
11. The method of any one of the preceding claims, wherein the second-order function is:

$$E(C, t) = x_0(c_i, t) + \sum_{i=1}^N x_i(c_i, t)c_i + \sum_{i=1}^N x_{ii}(c_{ii}, t)c_i^2 + \sum_{i=1}^{N-1} \sum_{j=i+1}^N x_{ij}(c_{ij}, t)c_i c_j;$$
where $E(C, t)$ is the at least one property, c_i , c_{ii} , and c_{ij} are the one or more parameters, and x_0 , x_i , x_{ii} , and x_{ij} are the coefficients; and t is time.
12. The method of any one of the preceding claims, wherein the plurality of sets of test values are obtained by orthogonal array composite design (OACD).
13. A system for optimisation of process parameters for printing a part by additive

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manufacturing, the part having a design, the system comprising:

at least one processor in communication with an additive manufacturing system; and

storage in communication with the at least one processor, the storage comprising instructions that, when executed by the at least one processor, cause the at least one

5 processor:

obtain test data of samples at least partially generated by the additive manufacturing system in accordance with the design and a plurality of sets of test values of one or more process parameters, wherein the test data is indicative of respective measurements of at least one property of the test samples for respective sets of test values at one or more times during

10 generation of the test samples;

fit the test data to a second-order function that relates the at least one property to the one or more process parameters to determine coefficients of the one or more process parameters; and

15 determine, based on the second-order function and the coefficients, optimal values for the one or more process parameters that result in a global optimum for the at least one property.

14. A system according to claim 13, further comprising the additive manufacturing system.

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15. A system according to claim 13 or claim 14, wherein the storage comprises instructions for causing the at least one processor to cause the additive manufacturing system to print the part according to the design and the optimal values for the one or more process parameters.

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16. A method of printing a part by an additive manufacturing system, the part having a design, the method comprising:

determining optimal values of one or more process parameters for the additive manufacturing system by a method according to any one of claims 1 to 12; and

30 causing the additive manufacturing system to print the part according to the design using the optimal values of the process parameters.

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17. Non-transitory computer readable storage comprising computer-executable instructions for causing at least one processor to carry out the method according to any one of claims 1 to 12 or claim 16.