FIG. 3 illustrates a side view of a printhead module.

FIG. 4 illustrates a top view of a printhead module.

FIG. 5 illustrates a perspective view of a feed material dispenser.

FIG. 6 illustrates a heat lamp array.

FIG. 7 illustrates a schematic of an exemplary additive manufacturing system.

DETAILED DESCRIPTION

An additive manufacturing system deposits a layer of feed material (for example, powders, liquids, suspensions, molten solids) on a platen, and then fuses portions of the layer of feed material. One or more feed material dispensers can deliver one or more feed materials to deposit the layer of feed material, and in some implementations the feed material can be selectively deposited by the one or more feed material dispensers. After the feed material is dispensed onto the platen, a spreader, for example, a roller or a blade, can spread the feed material over the platen to a higher uniformity or compaction, if desired. Fusing the desired portions of the layer of feed material can be achieved by supplying energy from one or more energy sources. The energy sources can apply energy to a spot, e.g., a single voxel at a time, or across an area, e.g., over multiple voxels simultaneously. For example, the energy source can include one or more lasers and/or arrays of heat lamps. The arrays of heat lamps can be located above or below the platen or elsewhere in the chamber of the additive manufacturing apparatus. Energy from the energy source heats up the feed material and causes it to fuse together to form a solid piece. The additive manufacturing system can also include one or more metrology systems that measure various parameters of the additive manufacturing process, for example, thermal/temperature uniformity, surface roughness or uniformity, image of the surface, and/or stress of the deposited feed material.

It is desirable to have a standardized printhead module that includes various printhead components, for example, a feed material dispenser, a heat source and an energy source. “Standardized” in this context indicates each printhead module is substantially identical in physical configuration (there can be software exceptions such as serial number or firmware version that vary between dispensers). The standardized printhead module simplifies construction and repair of additive manufacturing systems,

associated with the additive manufacturing process. The global metrology system can comprise one or more of a sensor, a thermal imager or an optical camera.

In one implementation, as the system 150 moves from left to right (along +y direction) across the platen 105, a first global metrology system 220 forms the leading edge of the system, followed by the printhead modules 210 which in turn are followed by a second global metrology system 222 at the end. The global metrology system 220 at the leading edge of the system 150 can therefore measure various parameters such as the temperature and/or vertical position of the surface, e.g., the platen or underlying layer, onto which the layer will be deposited. This data can be fed to the controller 190 to control operation of the printhead modules 210. For example, if the feed material dispenser is controllable, measurements of the height of the surface can be used by the controller to determine an amount of material to dispense to improve layer thickness uniformity. Similarly, the data on the temperature of the layer can be used to control the power delivered to the heat source and/or energy source so that the portions to be fused are raised to a uniform temperature. The global metrology system 222 at the trailing edge of the system 150 can measure the various parameters associated with the additive manufacturing process, for example, the temperature and/or surface roughness of the fused/melted feed material. Again, this data can be fed to the controller 190 to control operation of the printhead modules 210, e.g., in a feedback loop to provide improved uniformity.

In some implementations, the global metrology system 222 can be divided into several segments along the x direction such that each segment of the metrology system is responsible for taking measurements of feed material fused by one or more printhead modules.

In some implementations, the additive manufacturing process can be one-directional, i.e., the additive manufacturing process only occurs when the system 150 is moving from left to right or from right to left. In another example, the additive manufacturing process can be bi-directional, i.e., the additive manufacturing process occurs when the system 150 is moving both from left to right and from right to left. The global printing components 220 and 222 can either be similar (for bi-directional printing) or different (for unidirectional printing).

lamp array 600 comprises a plurality of heat lamps 634 that are arranged in an array, for example, a hexagonal closest packed array. Each heat lamp 634 can be connected to a power source through one or more pins 636.

The energy delivered to each heat lamp 634 can be controlled by a controller (for example, the controller 190 in FIG. 1). Changing the energy delivered to each of the heat lamp can change the energy radiated by the heat lamp. Therefore, the spatial distribution of energy generated by the heat lamp array can be controlled by the controller. As a result, the portion of the feed material deposited on the platen that receives energy from the heat lamp array 600 can have a temperature distribution. In other words, the heat lamp array 600 can provide control of the temperature distribution of the aforementioned portion of the deposited feed material.

In FIG. 6, the heat lamp array 600 is arranged along the z axis, and is therefore perpendicular to the feed material on the platen (which is in the x-y plane). However, the heat lamp array 600 can also be arranged at other angles to the platen. For example, the lamps could be angled in the y-z plane to move the region heated closer to the point at which the feed material is dispensed. As another example, lamps at the edges of the array (along the x-axis) could be angled outwardly (in the x-z plane) to provide heat to any feed material into a gap between two adjacent printhead modules of a printhead platform.

FIG. 7 illustrates a top view of an example of an exemplary additive manufacturing system 700. As described in FIG. 2, system 700 includes and is enclosed by a housing 102. The housing 102 can, for example, allow a vacuum environment to be maintained in a chamber 101 inside the housing. Alternatively the interior of the chamber 101 can be a substantially pure gas, e.g., a gas that has been filtered to remove particulates, or the chamber can be vented to atmosphere. The gas can enter the chamber 101, from a gas source (not shown), through a gas inlet 103. The gas from the chamber can be removed through a vacuum vent 104.

The printhead platform 750 is mounted on the rails 130a and 130b of the gantry 130. By sliding over the rails 130a and 130b of the gantry 130, the printhead platform 750 can traverse over the platen 105 (along y direction). The platform 750 supports a printhead module 710 that can be, for example, the printhead modules described in FIGS. 2, 3 or 4. The printhead module 710 is mounted on a track 730 and can move along