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THE USE OF A HONEYCOMB TO ELIMINATE THE IMPACT OF BACK REFLECTION

HP INC

The use of a honeycomb to eliminate the impact of back reflection

There are many existing technologies to produce 3D parts by means of “digital systems”. These systems are often referred to 3D printers or additive manufacturing technologies, and parts are built by adding successive layers of material (liquid, powder, or sheet material) from a series of cross sections, that are joined together or automatically fused to create the final shape.

In some 3D printers, IR lamps are used to fuse the parts. To make the system more efficient, these lamps use a combined reflector to maximize the radiation that is being delivered to the printed parts. However, the aim of maximizing the system efficiency requires a large surface reflector. As it is explained in the next section, that produces a negative effect, affecting the temperature of the printed parts, and producing a negative impact in part quality

A new concept consisting of a parabolic reflector and a honeycomb to eliminate the effect of back reflection on to the printed parts, allowing a much better temperature control and improving the robustness, in terms of part quality, of all printed elements.

Problem solved

In some 3D printers, a system of a few lamps next to each other with a combined reflector are used to add energy to powder. It is important that this energy is delivered as uniformly as possible to all the printed parts to have the maximum thermal control, which is required to have the most equalization on the part quality. When using a system of a few lamps and a combined reflector, the parts that are being printed (black) absorb almost all the energy, while the surrounding powder bed (white) is reflecting most of the radiation coming from the energy system. Since the emitting system is really close to the powder bed where the parts are being printed, an important amount of the emitted radiation is uncontrolled and is diffusely bouncing up and down between the reflector and the powder bed.

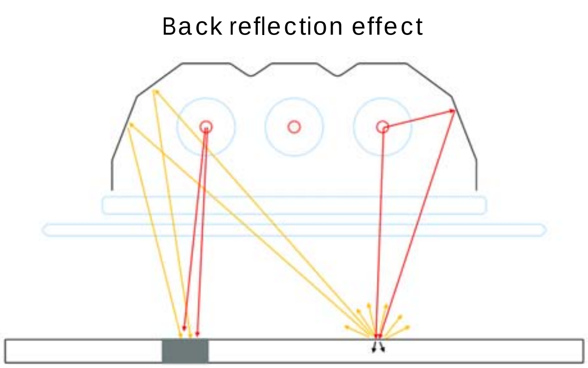

Figure 1

Since the surface of the combined elliptical reflector is large to maximize the efficiency, part of the radiation is reflected from the powder bed to the reflector, and from it back again to the powder. This effect does not stop until the trajectory of the reflected rays are absorbed by elements not surrounding the bed area (diverted away) or absorbed by a printed part (black). The effect of back reflection hinders the temperature control of printed elements, since it is totally depending on the shape of the parts that are being printed and their relative position in the bed.

To sum up, printed parts that have a higher content of black on its surroundings will receive a lower amount of energy than the parts that are mainly surrounded by white powder, which will receive a higher amount. This difference on absorbed energy lead to a difference in the melting temperature of the part, which will have a strong impact on its part quality.

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The described effect is one of the main contributors of having a non-uniform temperature on the printed parts and induces directly to part quality variability. It is absolutely dependent on the plot content, which is random and makes it very difficult to compensate.

Prior Solutions

The back-reflection effect is intrinsic of the Fusing System in some 3D printing systems. Currently, some printers use a compact ceramic reflector, which significantly decreases the back-reflection effect. However, even the global efficiency of the system remains the same and the back reflection is minimized, it is not eliminated.

For materials or applications that do require a much better temperature control, the new solution practically eliminates the back-reflection effect. However, it also has a higher tradeoff regarding the system efficiency.

Description

The system proposed is composed by: an IR emitter (halogen lamp); a parabolic reflector (directing a X % of the total emitted radiation from the lamp); a honeycomb to minimize the back reflection effect. Also, IR filters such as glasses can also be added to this system. The parabolic reflector directs the radiation perpendicularly to the printed bed. However, not all the radiation emitted from the lamp passes through the reflector, therefore not all the radiation is reaching the honeycomb in a vertical direction. This way, the honeycomb filters most of those rays that are not inciting in a perpendicular direction. When the powder bed reflects diffusively the radiation, the honeycomb only permits to pass those in a vertical direction, hence the re-radiation effect is highly minimized and compartmentalized. The critical parameters are the size of the cell (from *Figure 3*: **r** and **a**) and the depth of the honeycomb (from *Figure 3*: **h**). The first one will determine the sections where the rays are compartmentalized, while the height of the honeycomb will determine the percentage of the incident angles that have a certain deviation from vertical direction that still can pass the grid.

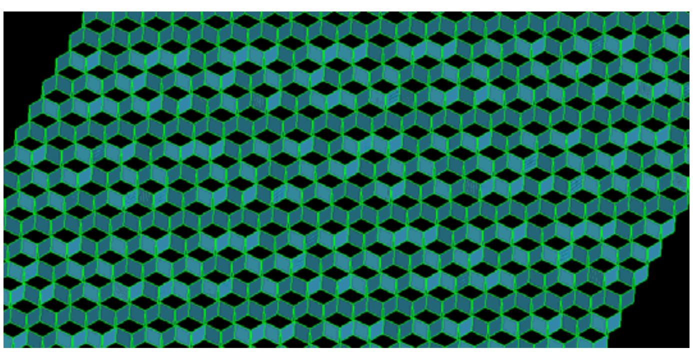

Figure 2

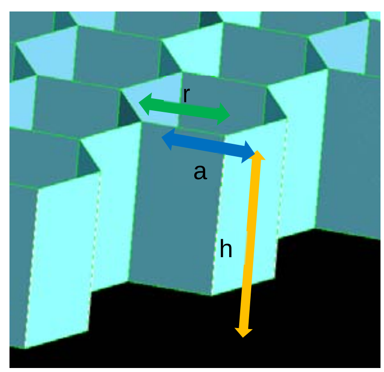

Figure 3

In *Figure 2* above, an example of honeycomb. Material can be chosen depending on system limitations. The material chosen for the honeycomb might include several options. Aluminum foils are the most standard option but do require an active cooling. A ceramic honeycomb is more robust regarding this aspect. Another critical parameter is the thickness of the foil: the thicker it is the lower the efficiency of the system.

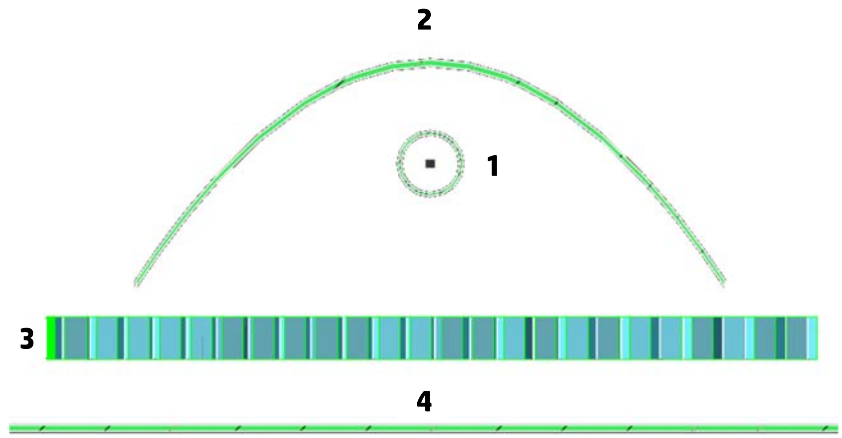

Figure 4

In *Figure 4* we can observe the cross section of the system proposed. The IR emitter (1), the parabolic reflector (2), the honeycomb (3) and the powder bed (4). Also, IR filters such as glasses can be included above and/or below the honeycomb depending on its main function. Finally, all the relative positions: lamp - reflector (1-2); lamp - honeycomb (1-3), reflector - honeycomb (2-3) with respect to the powder bed (4) also play a major role in determining the energy loss and effectivity regarding back reflection compensation (besides reflector geometry and honeycomb specific geometry).

Advantages and Disadvantages

The advantages of the proposed system are:

- Much better thermal control of the printed parts, isolating the energy that a single part is receiving from the plot content. This has many significant implications on the printed parts:
  - Improves their dimensional accuracy.
  - Improves their mechanical properties.
  - Improves their look and feel.
  - Improves printer productivity since the variability between printed parts depending on the density of the plot is smaller.
- Worse system efficiency.

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