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PLATFORM FOREIGN OBJECT DETECTION SYSTEM

HP INC

Platform foreign object detection system

Abstract

In powder bed AM (additive manufacturing) processes, a build is produced on top of a metallic build platform. The presence of foreign objects upon this platform can induce different problems, from motor servo shutdown to a fire hazard. Here we present an active thermography approach to detect such foreign objects before their presence can harm the system. The approach is based on the differential thermographic response of the build platform vs. common foreign objects to irradiative heating.

Problems Solved

The presence of a foreign object on the build platform in an AM machine is not uncommon. Tools can be forgotten after maintenance or repair, paper and writing utensils may be used near the printer and sometimes the build platform is the nearest convenient surface. If such objects are present when a build begins they may cause mechanical interference with moving parts within the printer (such as a mobile lamps module, printheads, recoater etc.). This mechanical interference may harm the system or cause a safety shutdown. Furthermore, the foreign objects may be flammable at the temperatures applied during printing and present a fire hazard.

Other objects may cause neither interference nor fire but, through the introduction of an unexpected thermal interface and optical object, may modify the thermal boundary conditions of the build, and thus jeopardize part quality. For example, a black object on the build platform will absorb more radiation than the platform and thus a build will begin at a higher temperature than expected, either locally or across the entire build platform.

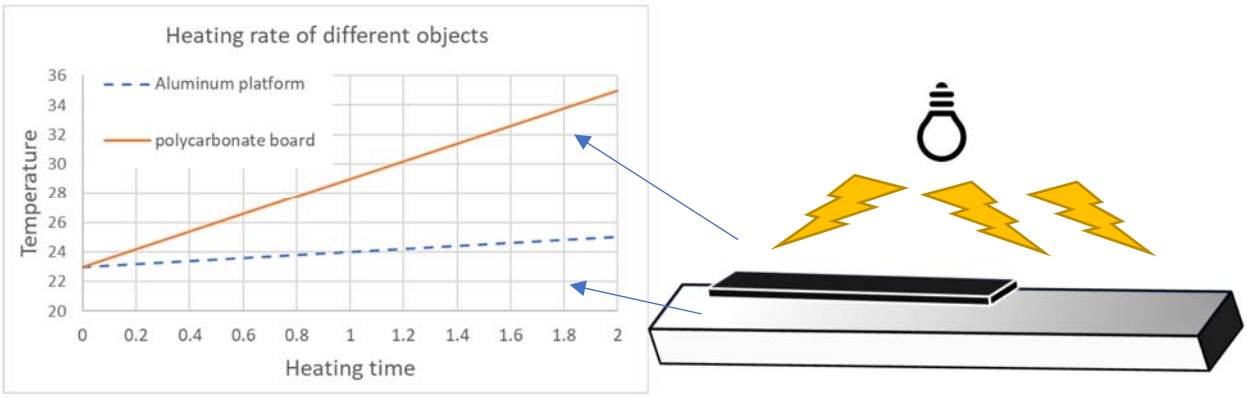
Description

The first step consists of applying heat onto the build platform for a short period. After the heat is applied, the thermal camera is used to analyze the heating rate observed at the build platform region. Foreign objects are likely to heat up faster than the platform. If an unusual heating rate is observed, be it local or across the entire platform, the build is cancelled and the user is prompted to inspect the platform.

When applying a heat flux h to an object during a short time t, the temperature increase, as observed by a thermographic camera, will show a quasi-linear increase, with a slope that is proportional to the absorptivity of the object and inversely proportional to its thermal capacity.

The build platform typically presents very low apparent heating rates due to a) the low absorptivity and emissivity (as it is made of metal) and b) its high heat capacity, being a solid object. Paper based materials and plastics are easily distinguishable under this kind of measurement due to their high absorptivity in the NIR-IR spectral range and low thermal capacity which leads to high observed heating rates.

A bare aluminum platform heated during 2 seconds with the full intensity of the top lamps shows a 2 ^{o}C temperature increase. The same build platform covered with PA12 powder heated in the same way shows an average 10 ^{o}C temperature increase. A black polycarbonate board heated the same way shows an average 12 ^{o}C temperature increase.



Schematic: Right: Illustration of test setup (heat source, platform and foreign object). Left: typical heating curve for a thick aluminum platform and a polycarbonate board during 2 seconds of heating.

Disclosed by Daniel Rosenblatt and Davinia Font, HP Inc.