Infrared Calibration Targets

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Introduction

Infrared calibration targets are used to calibrate all types of infrared equipment. The goal of this project was to create a large area thermal imaging target with a flat, uniform temperature radiating surface. The parts were fabricated out of aluminum using a rapid prototyping process known as ultrasonic consolidation.

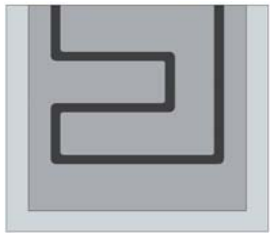
Multi-material Plate

The ultrasonic consolidation process can bond certain combinations of dissimilar metals. Another first generation plate was built to take advantage of this capability by inserting a 0.006 inch thick layer of copper near the surface of the part. Testing showed that the thermal uniformity of the part surface improved by 9% due to the higher thermal conductivity of the copper layer.

Embedded Copper Layer

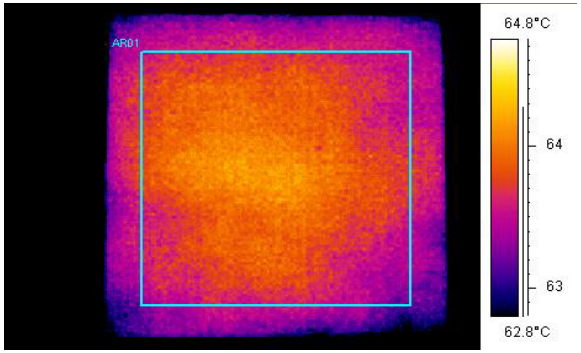
First and Second Generation Plates

These are flat aluminum plates with an internal channel through which coolant flows to heat or cool the plate. The design mimics drilled plate thermal targets and improves upon them by using more complex, patchless internal channels which are made possible by the ultrasonic consolidation process. The first generation plate was designed to prove that the ultrasonic consolidation could build infrared target plates. The second generation plate was developed to improve upon the thermal characteristics of the first generation plate.



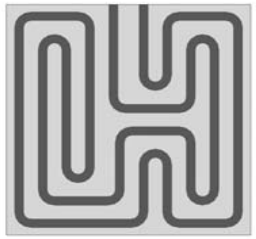
Channel Layout
First Generation Plate

Second Generation Plate



Second Generation Plate Thermal Camera Image

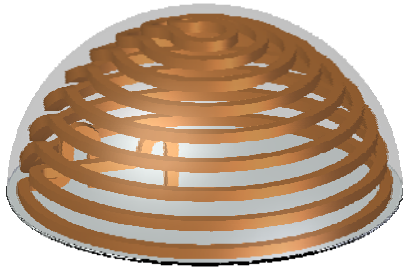
First Generation Plate



Channel Layout
Second Generation Plate

In testing 65° C water flowed through the internal channels with the part in a 20° C environment. The thermal uniformity of the radiating surface was measured using a thermal imaging camera. The first generation plate averaged 63.5° C with a standard deviation of 0.3° C. The second generation plate averaged 63.8° C with a standard deviation of 0.2° C. A method to confirm these temperatures is being researched.

Future Work



Conceptual Hemispherical Design

Using ultrasonic consolidation to build infrared targets opens a whole world of possibilities. The multi-material capability can be expanded to allow tailoring of thermal characteristics to meet a specific need. Additionally, parts with complex internal and external geometry can be fabricated.

Fabrication Characteristics

Two characteristics exist in all parts fabricated using ultrasonic consolidation – slight porosity in the lateral direction and reduced thermal conductivity in the build height direction. Porosity is overcome by applying any of a number of commercial porosity sealants. Reduced thermal conductivity is in most cases is just another parameter to track which may be a useful property in some designs.