Customized Phone Case Designed For Thermal Efficiency

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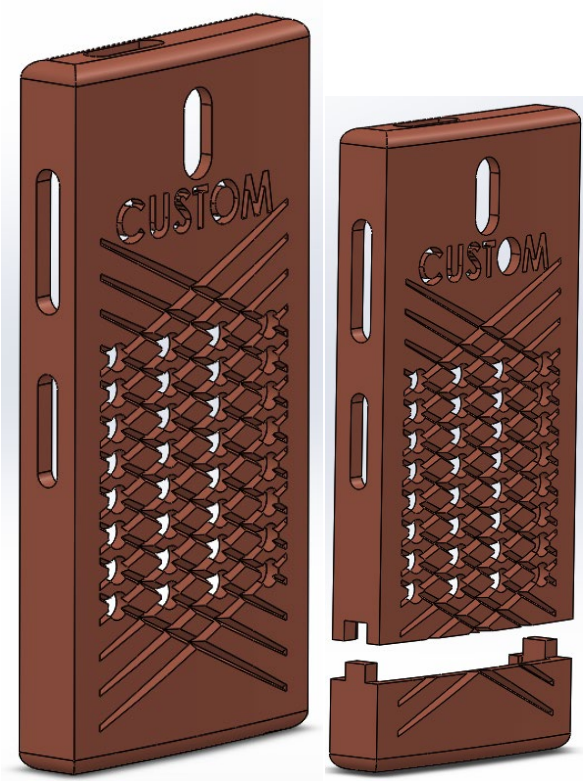

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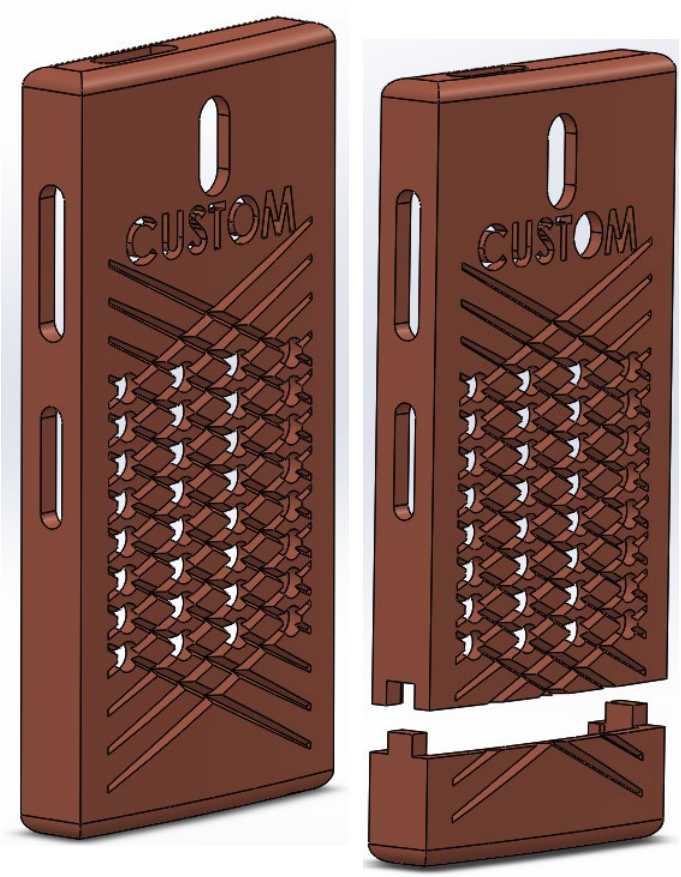
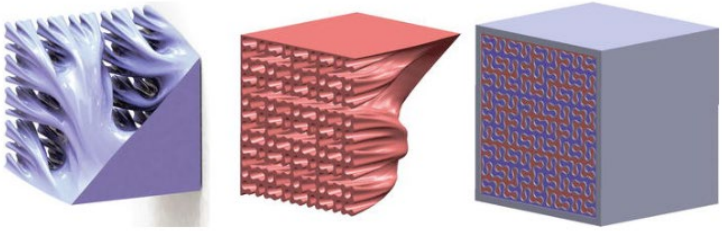
Description of Features and Functions



Overall Design- Designed is a thermally efficient phone case targeted towards users who care about battery life. There is a growing market for phone cases and an increasing need for users to save battery life and increase phone performance. By increasing thermal transfer through internal geometry and material, this case can increase long term battery life and increase day to day performance and reliability. Studies show that every 2 degrees Celsius of temperature reduction in a smartphone processor can increase the processor performance by 10%. Using Copper in an additively-manufactured phone case, processor performance could be improved by up to 40% due to copper's superior heat transfer properties. Furthermore, copper use will reduce the residual heat on the lithium ion battery because of this 8 degree Celsius temperature reduction.

Mechanics-The case is easily attached to the phone by snapping the bottom half onto the top half. This case will be recyclable, so the use of this phone case can be marketed to the 75% of customers who take into account corporate sustainability when making purchases.

The Internal Design-



The design shown above [1] is a thermally optimal design for a heat exchanger as studied by Uwe Scheithauer, Richard Kordaß, and peers. We propose this structure to be in the inner lattice of the phone case for optimal heat distribution.

Justification of the Additive Manufacturing Process

Justification of the Material and Process Selected

When considering the best material to be used for our phone case, we wanted to utilize a material that is both abundant in supply and one that exhibits high conductive heat transfer rates. The common metal with the highest thermal conductivity is Copper, with a rate of 223 [BTU/(hr·ft·°F)]. This rate is almost double that of the next leading common material for heat transfer, which is Aluminum at 118 [BTU/(hr·ft·°F)]. However, pure copper cannot be reliably printed yet, so alloys have been developed that are compatible with current additive manufacturing methods. Our team chose to use Chromium Zirconium Copper, which is Copper C18150 from Stratasys. C18150 has a thermal conductivity of 185 [BTU/(hr·ft·°F)].

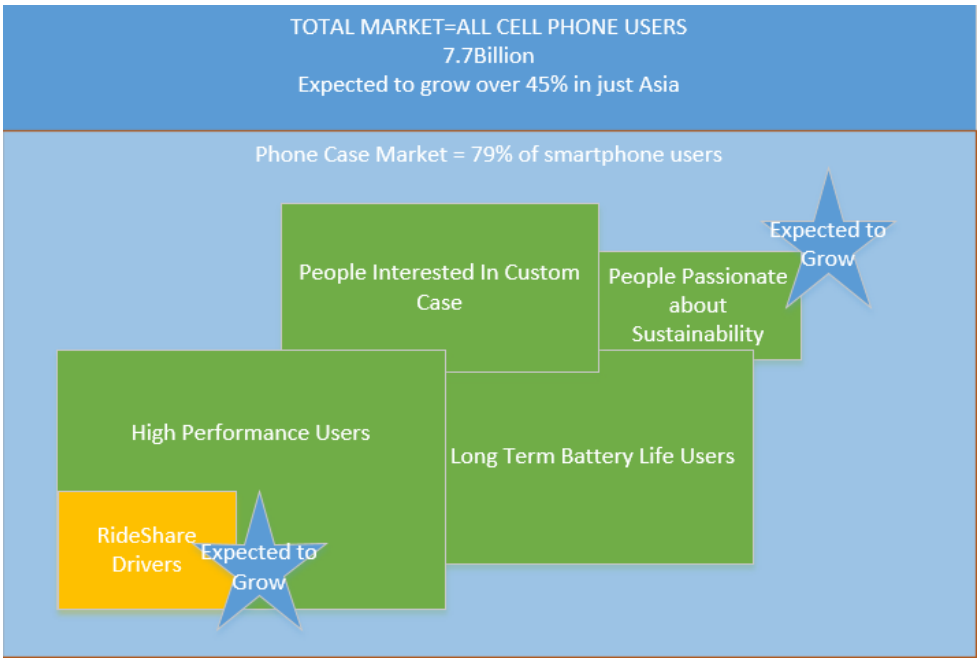
Direct metal laser sintering (DMLS), a type of powder-bed laser melting, is currently the preferred method for copper alloy additive manufacturing. DMLS is excellent for application in our phone case because it can produce parts that are 99.8% dense. This density is favorable to maintain continuous thermal properties and a strong, protective phone case. Although DMLS is only suitable for small production parts, this seems to pose no problem for our product as the phone cases will not exceed current size limitations. Additionally, DMLS does not exhibit perfect surface finishes, but further processing would likely not be required because the textured phone case surface should be pleasant to handle from a consumer's point of view. In the realm of metal manufacturing, DMLS is one of the best options for complex designs like the tapered fins on our phone case. Cost-Assuming a price for 50 lbs of copper atomized powder to be $557.50 and a phone case volume of 55 cm^3, the cost of production is approximately $12.12/each.

Additive Manufacturing Capabilities and Comparison to Traditional Methods

One of the important advantages of additive manufacturing is its customization ability. Manufacturing a die with the geometric intricacies of the star shaped pins (in the internal design) is expensive and time consuming. Moreover, phones come in different sizes and it is almost impossible to produce dies for each type of phone since the sizes of the pins varies for each model. For any minor changes in the design, new tooling is required which will lead to skyrocketing prices of the phone cases. If the holder is manufactured using the traditional methods, then there is a lot of assembly involved in putting the parts together. Assembly not only reduces the quality of the component but also increases the cost, especially labor being expensive in the United States. But in additive manufacturing, there is no need to assemble the components of the holder as it can be manufactured as a single entity. So, additive manufacturing makes the job easier. Moreover, additive manufacturing is automatic and there is no need for manual supervision. Total customization is possible by accepting the innovative ideas of the customers themselves into the design since today's market is customer-driven.

Market Analysis

Market Appeal:
The primary purpose for a cell phone case is protection. Users want to reduce the risk of fall damage and increase the longevity of their device. Our case takes it a step further by targeting the thermal efficiencies of a cell phone. The value added from this case is threefold- Increase in battery life, Increase in processor performance, and increase is strength in comparison to a regular phone case. On top of these technical advantages, it is customizable to any phone. Our target market will be the next generation of smartphone users who are willing to pay mid-range prices for sustainable and green products.



Market Share Forecast:
Smartphone usage is expected to reach 6.1 billion by 2020. There are relatively fast paced growing markets in Asia, Africa, and the Middle East. Considering that 79% of users report using a phone case in 2017 and that number continues to grow, there is a sizeable market for our product. We are targeting 10,000 cases over the next 4 years considering there are over 7 billion phone users, and 40% experience slowdowns in battery life or performance. Quality phone cases today retail for up to $100 or more, so our team believes that margins would be acceptable and that there would be a feasible business model for this product.

Social and Environmental Impact

The world in 2019 is highly dependent on lithium and other elements to create batteries for our phones, tablets, and electric vehicles. According to the Cairn Energy Research Advisors, the lithium ion industry is expected to grow from 100 GWh of annual production in 2017 to almost 800 GWh of energy storage in 2027. This acceleration of battery production is leading to a mineral crisis -- the elements we need to manufacture current battery technology (lithium, cobalt, and nickel) are concentrated mainly in developing countries and there are many negative externalities associated with their mining. Lithium processing contaminates natural water sources and can lead to the death of fish and other animals that swim in or drink the water. The mining process destroys the landscape and pollutes nearby areas with byproducts from the operation. The world's cobalt reserves are mainly concentrated in the Democratic Republic of the Congo, and child labor is often used to mine the toxic metal without protective equipment. Our phone case design is a step in the right direction toward finding ways to reduce consumption of lithium ion batteries while energy storage technologies are being discovered that are friendlier to the world's people and the global environment. Mining communities will be better off by optimizing lithium battery life while people using battery-powered devices will enjoy the performance benefits of our additively-manufactured phone case. At the end of our product's life cycle, the copper is more easily recyclable than plastics and can be processed into new material for sustainable manufacturing processes. Recycling metals like copper and aluminum saves 95% of the energy associated with mining these raw materials from the earth.

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