3D SOLID MODELING THE EFFECTIVE WAY OF EXTRACTING WEIGHT OF PRODUCTS SUB-PART MATERIALS

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ABSTRACT

In today's rapidly evolving technological landscape, 3D modeling applications have become increasingly prevalent across various industries. 3D modeling has revolutionized traditional processes and propelled innovation to new heights. This paper delves into how 3D modeling is utilized in extracting the product component's weight by creating scaled digital models.

It is difficult to manually extract the weight of product components especially when the parts are composed of a pre-assembled or composite material. This may require laboratory test analysis methods to precisely get the data.

Utilizing 3D modeling technology and the advancement of software and hardware to generate virtual products is the best alternative. Digital prototypes of each product component are drawn and modeled into scales to precisely represent the actual size and properties of product parts. This is a much easier approach and more effective way to be able to declare precisely 100% of the product's chemical content in terms of weight.

This paper discusses the methodology of extracting the weight of each substance of the ACC (Air Cavity Ceramic) package with a target error of 2% or less from the actual product weight.

1. 0 INTRODUCTION

Extraction of material weight is straightforward for individual parts, but for the semi-assembled parts and components it needs to break into individual parts to get the data. For composite materials, this may require sending samples to an elemental or quantitative material analysis laboratory to extract the precise data.

The general objective of this study is to create a simple and effective way of extracting the product component weight without sending samples to the laboratory or breaking materials into parts but rather by creating a virtual part through 3D modeling. The Air Cavity Ceramic package (SOT467C) is a hermetically sealed flanged ceramic package with 2 mounting holes and has 2 leads. It is composed of 2 major parts, the Header Assembly (see Fig.1.1), and the Cap (see Fig.1.2).

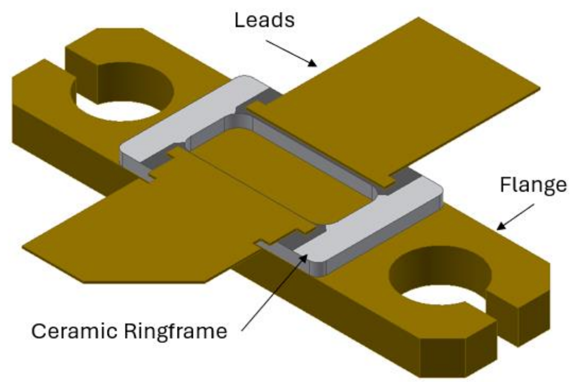


Fig. 1.1 Header Assembly has 3 materials the Flange, Ceramic Ring frame, and the Leads. These 3 materials are fused together.

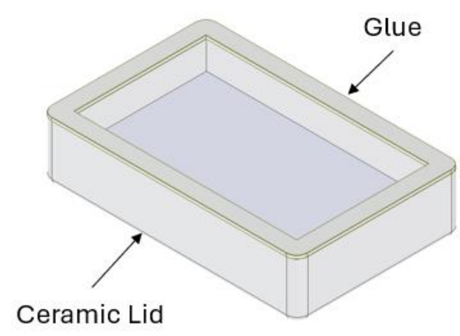


Fig. 1.2 Cap is made of a ceramic lid with pre-dispensed glue around the open edge.

Table 1. Actual weight of SOT467C major parts (4 samples)

Product Parts	**Actual Product Weight (mg)**			
Header Assy	**1589.70**	1593.50	1590.40	**1603.10**
Cap	**245.10**	248.60	250.70	**255.60**
TOTAL	**1834.80**	**1842.10**	**1841.10**	**1858.70**
AVERAGE	**1844.175**			

1.1 The conventional way of extracting material weight.

The conventional way of getting the material weight is through using the scale. Pre-assembled materials can be split individually and then weighed to get the data. Results are often inaccurate and take time and several samples to get the desired results. There is an enormous challenge when the materials are too small to measure or difficult to disengage from the assembly, considering also the pre- and post-plating treatment of the materials.

2. 0 REVIEW OF RELATED WORK (NOT APPLICABLE)

3.0 METHODOLOGY

In this study, the total actual weight measurement of the SOT467C ACC package and the sub-parts is measured (see Table 1) as a reference for comparison with the simulated and digitally extracted weight of the package and its individual parts.

Technical drawings and material datasheets are the main references in generating digital prototypes. Advanced 3D modeling software is used to create a virtual part of the products or packages.

The basic steps to extract the material weight of the parts using the software are the following:

1. Creates assembly model of the product/package. All parts must be modeled in scale. (see Fig.2.0-2.1)

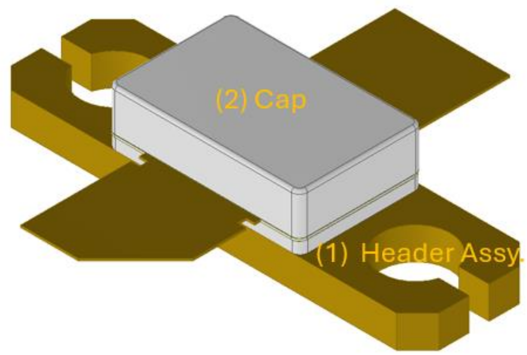


Fig. 2.0 Hermetically sealed SOT467 ACC Package.

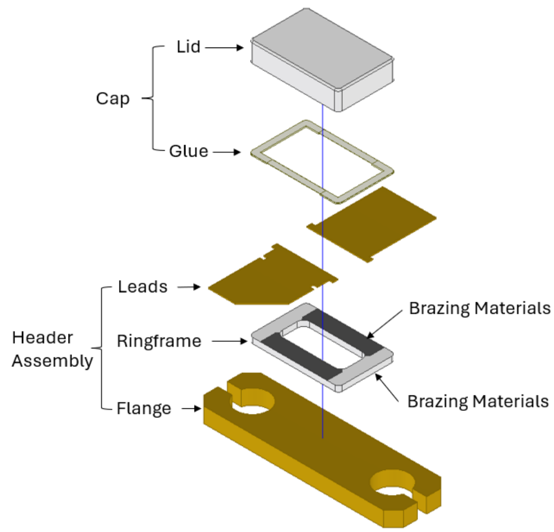


Fig. 2.1 SOT467C package subparts.

2. Apply material type for every part. (see Fig. 2.2)
3. Input material properties of the part including the material density in the material editor tab. (Material Technical datasheet is the reference).

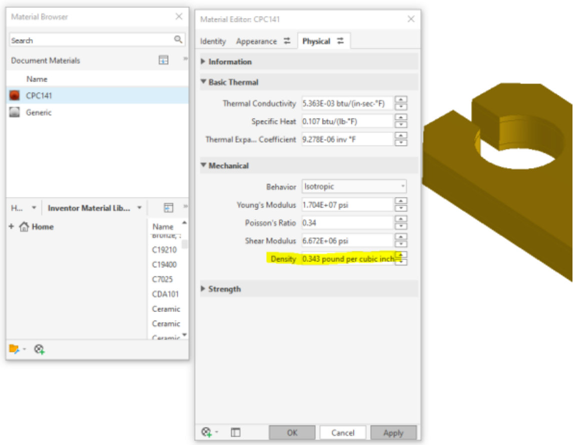


Fig. 2.2 Flange material is CPC141 with a density of 0.343 lb/in^2.

4. Open the part to undergo the material weight extraction process. In the user interface model browser tab, right-click on the part and click the iProperties from the drop-down menu. The parts property window will display, and the mass of the parts can be viewed under the physical tab. (see Fig. 2.3)

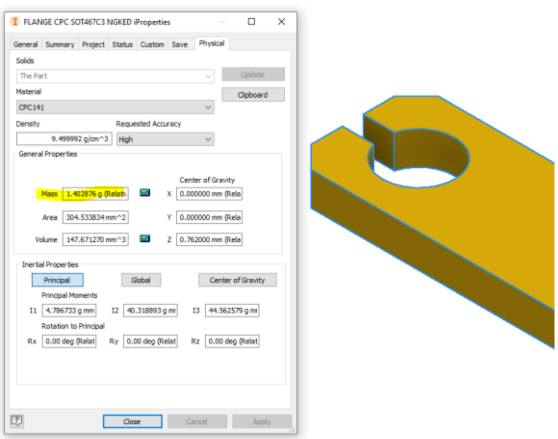


Fig. 2.3 Flange mass (1.402876 g) is displayed under the physical tab.

Perform steps 2-4 until all the parts material weights are available. The results of the remaining parts are placed in the appendix.

Sub-parts materials with pre-plating treatment can be manually computed from the available results on iProperties window. With the parts' surface area available and if the plating thickness and material are known this can be theoretically computed. A quick way to extract plating weight is by creating a shell on the parts, using the plating thickness specification, and applying plating materials and density. Check iProperties to get the weight of the shelled parts for plating material weight. (see Fig. 2.4)

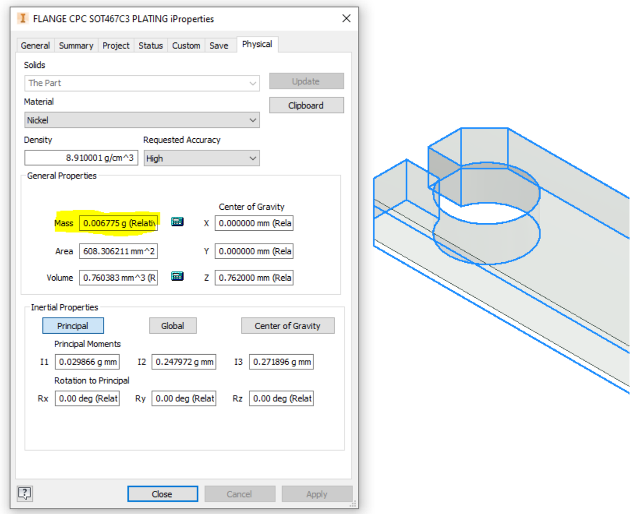


Fig. 2.4 Flange nickel-cobalt plating mass is 0.006775 grams.

Digitally extracted material weights are tabulated and summed up to compare with the actual sample weight.

Table 1. Summary of Digitally extracted weight of product sub-parts.

Product Component	Product Weight(mg) (Average)	Digitally Extracted Weight(mg)
Header	**1594.175**	**1597.779**
-Flange, CPC141	-	1402.876
-Plating, NiCo	-	6.775
-Plating, Au	-	14.910
-Ringframe, Al_2O_3	-	72.776
-Leads, Alloy42	-	63.152
-Plating, NiCo	-	9.217
-Plating, Au	-	2.467
-Brazing, CuSil	-	25.606
Cap	**250.000**	**252.967**
-Ceramic Lid, Al_2O_3	-	250.456
-Glue,	-	2.511
TOTAL	**1844.175**	**1850.746**

4.0 RESULTS AND DISCUSSION

The model created for every part is nominal except for precious plating material which is in minimum specification. Comparing the results of digitally extracted weight to the average weight of the actual samples, it shows tremendous accuracy with only 0.36% delta.

The results can be further subdivided into chemical content. and specifies the elemental content of each part's material in terms of weight.

Throughout the exploration, you've seen how 3D modeling enables engineers and designers to visualize life-like products and be able to extract expansive properties from the digital prototypes being generated.

5.0 CONCLUSION

Based on the results, 3D solid modeling and digital prototyping is an effective way of extracting the material weight of partially assembled parts, small components, and plating materials precisely to ensure an accurate declaration of the product's chemical content.

The degree of accuracy obtained may vary depending on the material specification, construction, and compositions.

6.0 RECOMMENDATIONS

The study shows a sample application for the SOT 467C Air Cavity Ceramic (ACC) package, it can be tried also on other types of packages such as the Over molded package, Air Cavity packages, Quad Flat No leads packages, or similar, and the Land Grid Array package type.

7.0 ACKNOWLEDGMENT

The authors would like to thank the Sustainability Group, Materials, and Design Engineering group for gathering technical details and sphere heading communications with materials suppliers for the reference drawing and material datasheets.

8.0 REFERENCES

1. Material Technical Datasheets.
2. Material Technical Drawing.
3. Periodic Table of Elements with Density.
4. Autodesk Inventor Material Library

9.0 ABOUT THE AUTHORS

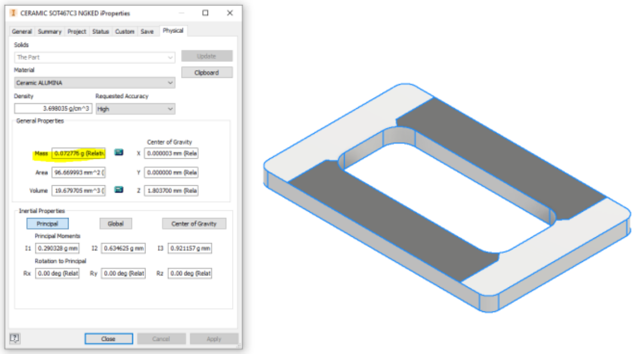
Gerardo A. Alvano is a graduate of BS Mechanical Engineering at the Technological Institute of the Philippines. A Mechanical Designer for the past 20 years. He is currently under the Quality and Materials Engineering Group. Gerry is directly involved in early Package development programs, generating digital prototypes, helping in tooling design study, checking adaptability to current manufacturing set-up, and ensuring products conformance to quality.

Zorayda S. Labausa is a graduate of BS Chemical Engineering at Saint Louis University Baguio City. She has ample experience in the field of the semiconductor industry. She has been a DL for almost 3 decades as a quality outgoing Inspector, FA laboratory assistant, and material Engineering technician. She is a Junior Product Sustainability Engineer at AMPLEON Manufacturing Philippines, Inc. ensuring new development AMPLEON products comply with environmental regulations and legislation.

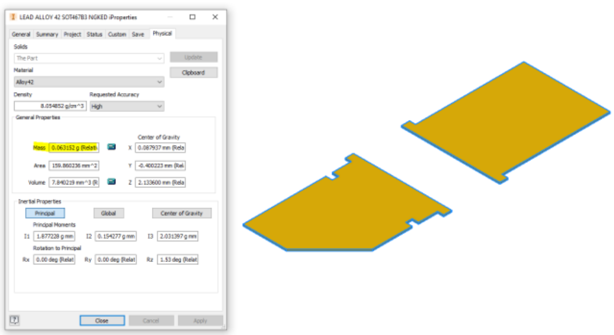
Derrick Maravilla is an Industrial Engineering graduate from Rizal Technological University. His career began as a part-time CAD operator at EVAPIA Precision Tooling, where he honed his skills in tooling design. Upon graduating, Derrick embarked on a new chapter at AMPLEON Manufacturing Philippines, Inc. as a dedicated Design technician. In this role, he specialized in supporting a range of products including ACC, ACP, OMP, DFN, QFN, and LGA, with his passion for innovation and attention to detail.

10.0 APPENDIX

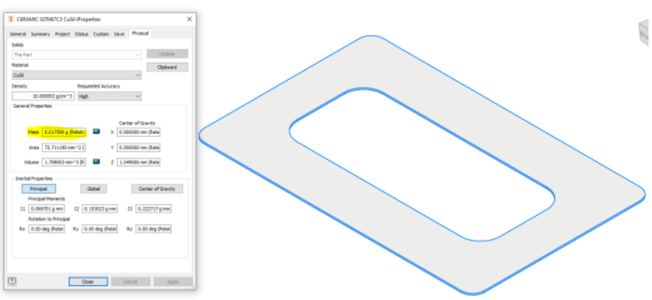
The following figures are the extracted weight of the SOT467C package which is too bulky to be placed in the methodology chapter.



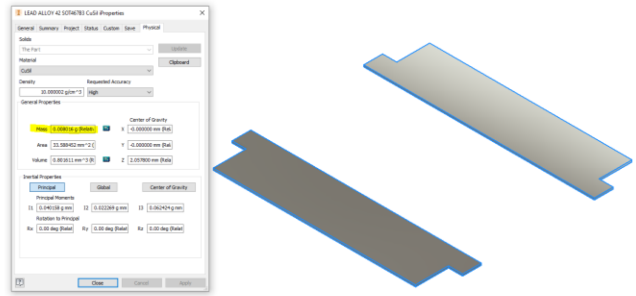
APPENDIX A. Extracted weight of Ceramic ring frame (Al_2O_3, 0.072776 grams).



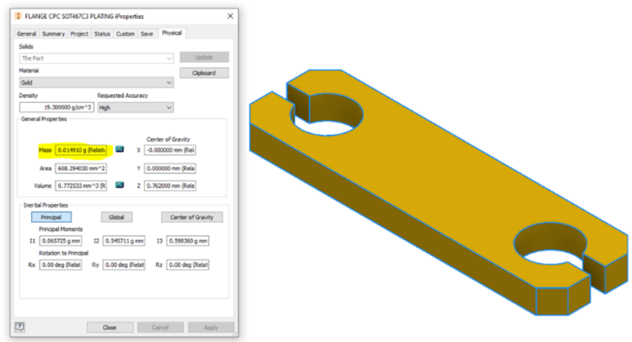
APPENDIX B. Extracted weight of Leads (Alloy42, 0.063152 grams).



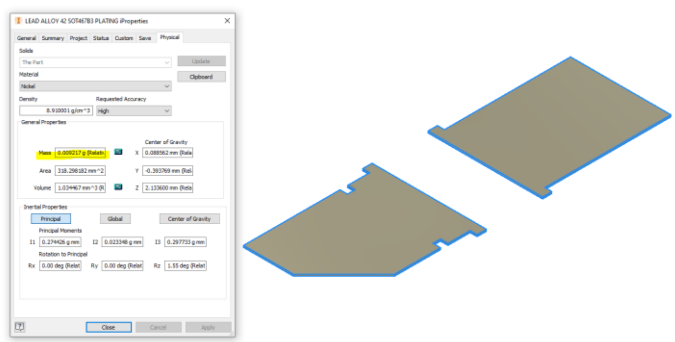
APPENDIX C. Extracted weight of Brazing materials Flange to Ring frame. (CuSil, 0.017590 grams).



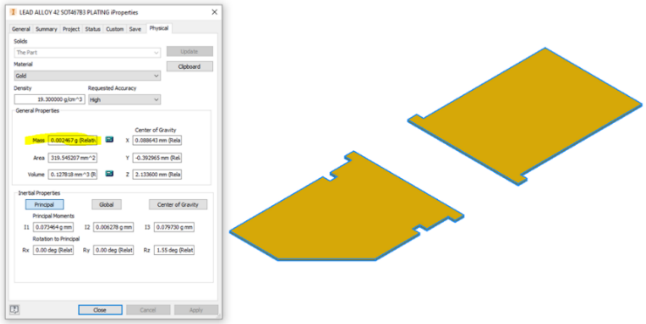
APPENDIX D. Extracted weight of Brazing materials ring frame to Leads (CuSil, 0.008016 grams).



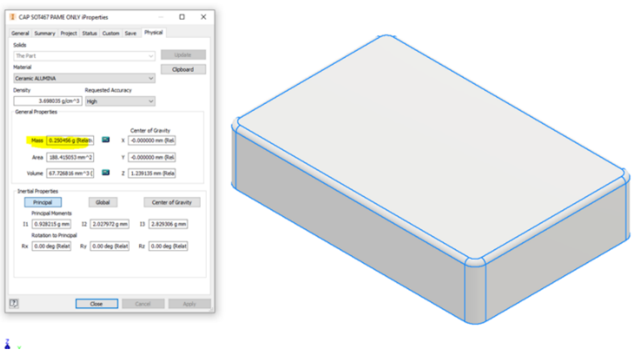
APPENDIX E. Extracted weight of Flange plating materials (Gold, 0.014910 grams).



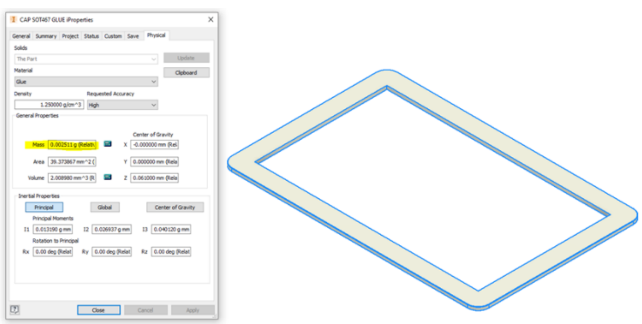
APPENDIX F. Extracted weight of Lead plating material (Nickel-Cobalt, 0.009217 grams).



APPENDIX G. Extracted weight of Lead plating material (Gold, 0.002467 grams).



APPENDIX H. Extracted weight of Ceramic Lid (Al_2O_3, 0.250456 grams.



APPENDIX I. Extracted weight of Pre-dispensed Glue in Ceramic Lid (0.002511 grams)

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