

MARKET OPPORTUNITIES FOR THERMAL MANAGEMENT COMPONENTS IN SMARTPHONES

Market & Technology report - November 2017

How can smartphones deal with growing heat management challenges?

KEY FEATURES OF THE REPORT

Get the sample of the report on www.i-Micronews.com

- Detailed discussion about trends in smartphones and how they will impact the needs for enhanced thermal management solutions
- Deep insights into different smartphone components and their role in thermal management
- Focus on different strategies to deal with thermal issues in smartphones, including: software and hardware thermal management; reducing heat-generation by using chips with lower thermal losses; using thermally-enhanced smartphone solutions for packaging and PCBs; enclosures; heat pipes; and vapor chambers
- Market forecast in millions of dollars for thermal management components in smartphones for 2017–2022
- Overview of main suppliers for key thermal management components in smartphones

OBJECTIVES OF THE REPORT

- Provide a clear overview of the smartphone thermal management solutions, covering “hardware” solutions and software thermal management
- Furnish market data for thermal management components in smartphones
- Present the technology trends for smartphone thermal management components
- Deliver an overview of the main suppliers of key components

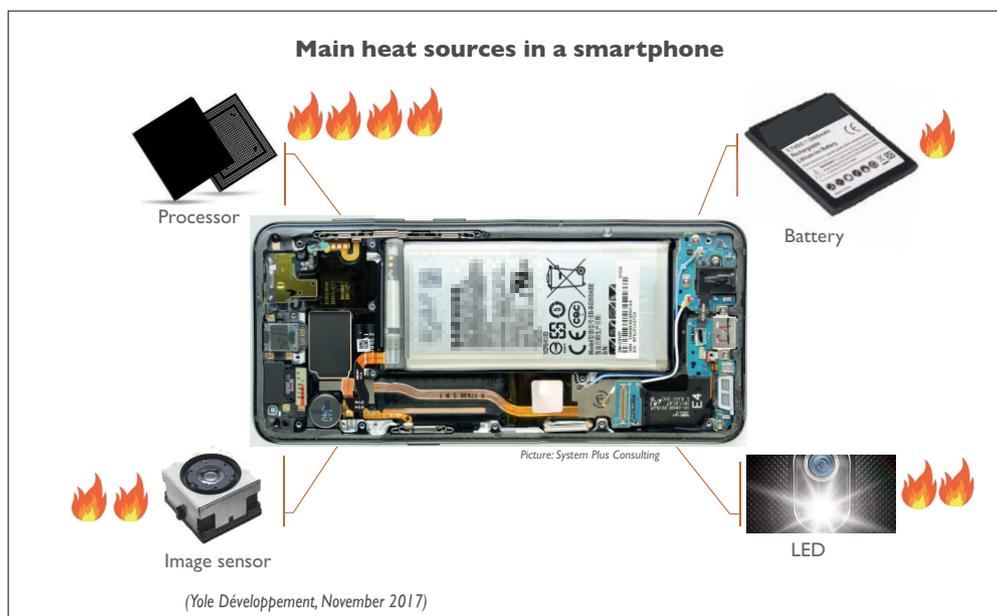
GROWING THERMAL CHALLENGES WITHIN A BOOMING SMARTPHONE MARKET

The growing smartphone market, expected to reach almost \$2.1 billion smartphones annually by 2022, represents a great opportunity for suppliers of different smartphone components and technology solutions.

Thermal management of handheld devices, such as smartphones, is becoming increasingly challenging. As detailed in the report, the main reasons for this are the growing number of smartphone functionalities and raised customer requirements for processing speed, leading to increased heat dissipation. Additional components needed to ensure new smartphone functions desired by customers, including wireless charging, high-resolution cameras, 3D gaming, security, authentication, and high-speed streaming, also result in denser component integration, making thermal management even more difficult.

Actually, smartphones contain several components that generate heat, and components whose performance and lifetime is negatively impacted by heat. Excessive heating of some components, such as lithium ion batteries, has to be avoided for safety reasons. The processor is the hottest component in a smartphone. Amongst other heat-generating components in a smartphone are image sensors, light sources and the battery.

Suitable thermal management solutions are now sought to avoid hot spots in smartphone and keep the component temperature at acceptable levels. The enclosure temperature, or skin temperature, must be also kept relatively low to avoid users feeling uncomfortable when using the smartphone.



WHAT ARE THE THERMAL SOLUTIONS IN SMARTPHONES?

Smartphones pose a significant challenge to the implementation of traditional cooling schemes, such as heat sinks and fans, due to form factor limitations and the specific way the device is used by customers.

As detailed in the report, there are different approaches for thermal management, based both on hardware and software solutions. Software thermal management (STM) has several advantages. It enables additional

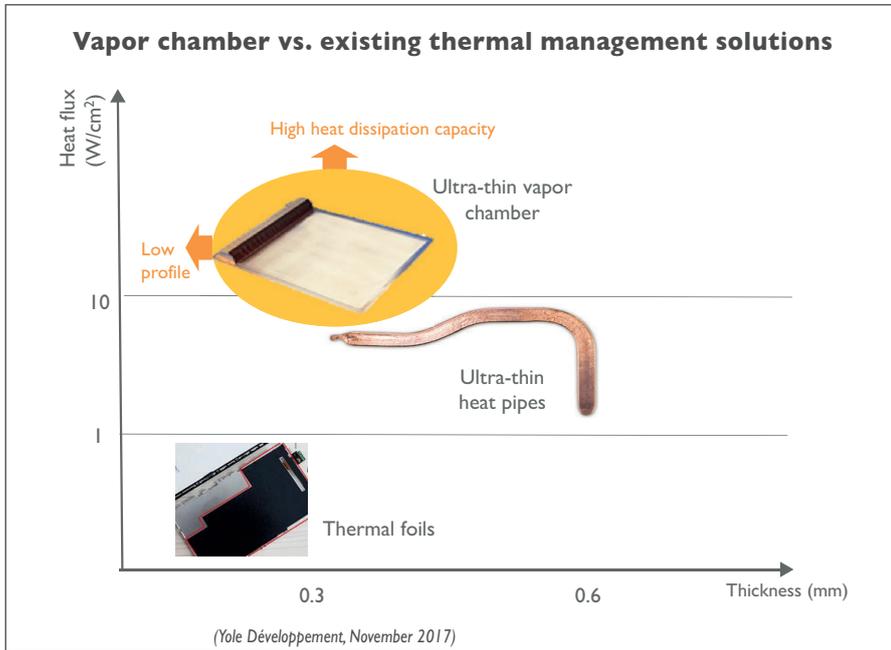
design flexibility and an optimal reaction to a given thermal event and can be improved by a software update in existing products. Contrary to hardware solutions, such as heat pipes, STM does not take additional space in smartphone.

The optimal way to deal with heat in smartphones would be to reduce heat

generation, by using higher performance chips. Significant improvements have been made in chip manufacturing, with the 10 nm node introduced in 2016, and chip architectures, including multiple core architectures, with “high-power” and “low-power” cores, associated with appropriate software control. However, in the future, processor improvements might be not fast enough to follow rapidly elevating customer requirements for smartphone functionality and performance.

So other thermal management solutions will increasingly be needed. As shown in the report, similar trends were observed in the past, when thermal transfer sheet performance was not sufficient to dissipate heat from poorly thermally designed processors, leading to heat pipes being introduced into the first smartphones from NEC and Sony. Today, the Samsung Galaxy S8, LG G5, Google Pixel 2 XL are just a few examples of smartphones relying on heat pipes to improve their thermal management.

Alternatively, vapor chambers might perform better than heat pipes in the near future. Ultrathin vapor chambers are already under development by several players, such as Furukawa Electric, TaiSol, AVC and Delta, but still face difficult technology challenges.



TECHNOLOGY INNOVATION IN THERMAL MANAGEMENT IN SMARTPHONES AND THEIR SUPPLIERS

Until recently, the thermal management in smartphones was only of minor interest to smartphone component and device designers.

Beside some “dedicated” thermal management components like heat pipes and thermal transfer sheets, most smartphone components have been designed and built without thermal performance in mind.

According to Yole Développement’s analysis, this will greatly change in the future. A fierce battle

for each mm³ of volume available in smartphones to implement components enabling new functionality and for larger batteries will lead to efforts to enhance thermal characteristics of existing smartphone components, instead of adding dedicated bulky thermal components.

Future efforts will be focused mainly at the packaging level, in chip packaging and Printed Circuit Boards (PCBs). These two solutions will account for more than ¾ of the \$3.6 billion market for thermal components solutions by 2022. Fan-out packaging solutions and high-density thermally-enhanced PCBs will especially attract interest. Amongst other, leading PCB suppliers such as Mektec, Samsung Electro-Mechanics, AT&S and Unimicron, and leading packaging suppliers such as Amkor Technology, ASE, TSMC and STATS ChipPAC will take part in this spectacular thermal transition in smartphones. The integration of several functions into one component is another promising approach for future smartphones.

Despite cost barriers in the cost-sensitive smartphone industry environment, the huge quantities of thermal management components needed result in attractive market value. Moreover, new technology solutions add more product-differentiating value compared to their competitors and open market opportunities in other applications areas, such as medical, gaming, pico-projectors, virtual reality and drones.

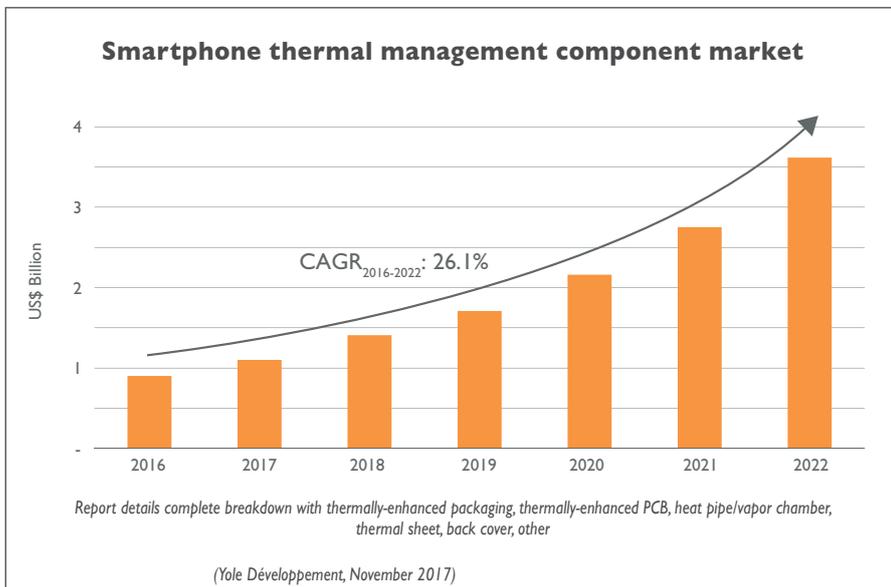


TABLE OF CONTENTS (complete content on i-Micronews.com)

Introduction	7	> Packaging in smartphones: still little focus on thermal characteristics
Executive summary	12	> Benefits of fan-out packaging over other packages
Global smartphone market trends	43	> Comparison of different packaging technologies in smartphones
Thermal issues in smartphones	48	> Underfill
> Main reasons why a smartphone gets hot		> PCB materials
> What are the main heat sources in a smartphone?		> PCB and thermal management in smartphones
> Thermal management priority levels		> PCB surface area in different smartphones – comparative graph
> Thermal management solutions in smartphones		> Smartphone PCB main specifications
> Classification of thermal management solutions in a smartphone		> PCB – how to improve thermal spreading capability?
> Different ways to deal with heat in a smartphone		Thermal sheet
> TM solutions at different packaging levels		108
> Synergies of TM for smartphones with other applications		Heat pipe and vapor chamber
Technology and market challenges	62	112
> Challenges to thermal management in smartphones		> Advantages & inconvenience of using heat pipes in smartphones
> Factors strengthening smartphone TM challenges		> Heat pipes in smartphone - Timeline
> Smartphone cooling system features sought		> Heat pipe as thermal management improvement in Samsung Galaxy S7
> Smartphones are getting slimmer and slimmer – or, are they?		> Comparison heat pipe & graphite thermal sheet
Market forecast	71	> Vapor chamber structure and principle
> Methodology		> Heat pipe vs. vapor chamber in smartphone applications
> 2016-2022 smartphone market in Munits		Battery
> 2016-2022 smartphone market value in \$ million		123
> Leading smartphone companies in 2016 – units sold per year		Smartphone enclosure
> Leading smartphone companies in 2016 – revenues		128
> Smartphone bill of materials in 2016		Other thermal management components
> Smartphone thermal management bill of materials in 2016 and 2022		135
> Market value of thermal management components in smartphones		> Air fan/air blower
Smartphone components and their role in thermal management	84	> Heat absorbent films/pads of Phase change materials
Processor	86	> Thermoelectric cooling
> Hardware and software improvements		> Midframe
> Single-core vs. multiple-core processor		Software solutions for thermal management in smartphones
> Comparative table of different processors		143
> Low efficient processor → additional thermal solutions needed		Technology trends
Packaging and PCB	92	151
> Smartphone as a driver for packaging development		Wireless charging
		164
		Thermal characterization, simulation and testing
		170
		Supply chain
		172
		> Smartphone microprocessor and software management supply chain
		> Packaging: Fan-out manufacturers
		> Packaging: Fan-out supply chain
		> Underfill players
		> Heat pipes: who supplies who?
		> Vapor chamber developers for smartphones
		> Smartphone PCB suppliers
		Conclusions
		182

COMPANIES CITED IN THE REPORT (non exhaustive list)

Amkor Technology, AT&S, Apple, ARM, ASUSTeK Computer, Inc. (ASUS), Auras, Asia Vital Components (AVC), Broadcom, CCI, Compeq Manufacturing, DECA Technologies, Furukawa Electric, Huawei, Coolpad, HiSilicon, Henkel, Huawei, HTC, Intel, Lenovo, LG, Mediatek, Microsoft, Nvidia Corp., Nanium, Nippon Mekron, NXP, Oppo, Qualcomm, Samsung, Samsung Electro-Mechanics Co, Ltd, Schoeller Electronics Systems, SONY, STATS ChipPAC, Vivo, Taisol Group, TCL, Tripod Technology, TSMC, Xiaomi, Zhen Ding Technology, ZTE, and more...



AUTHORS

Dr. Milan Rosina is a Senior Analyst for Energy Conversion and Emerging Materials at Yole Développement. Before joining Yole, he worked as a Research Scientist and a Project Manager in the fields of photovoltaics, microelectronics, and LEDs. Dr. Rosina has more than 15 years of scientific and industrial experience with prominent research institutions, an equipment maker, and a utility company. His expertise includes new equipment and process development, due diligence, technology, and market surveys in the fields of renewable energy, energy storage, batteries, power electronics, thermal management and innovative materials and devices.

This report has been performed in collaboration with **Mattin Grao Txapartegi** and **Jonathan Liao** both analysts part of the Power Electronics, Compound Semiconductor and Energy Management team at Yole Développement.

RELATED REPORTS

Benefit from our Bundle & Annual Subscription offers and access our analyses at the best available price and with great advantages



- Status of Advanced Packaging industry 2017
- Advanced Substrate Overview: From IC Package to Board

Find more details about this report here:



ORDER FORM

Market Opportunities for Thermal Management Components in Smartphones

BILL TO

Name (Mr/Ms/Dr/Pr):

Job Title:

Company:

Address:

City:

State:

Postcode/Zip:

Country*:

*VAT ID Number for EU members:

Tel:

Email:

Date:

PAYMENT

BY CREDIT CARD

Visa Mastercard Amex

Name of the Card Holder:

Credit Card Number:

□□□□ □□□□ □□□□ □□□□

Card Verification

Value (3 digits except AMEX: 4 digits):

□□□□

□□ / □□

Expiration date:

BY BANK TRANSFER

BANK INFO: HSBC, 1 place de la Bourse,
F-69002 Lyon, France,
Bank code: 30056, Branch code: 00170
Account No: 0170 200 1565 87,
SWIFT or BIC code: CCFRFRPP,
IBAN: FR76 3005 6001 7001 7020 0156 587

RETURN ORDER BY

- FAX: +33 (0)472 83 01 83
- MAIL: YOLE DÉVELOPPEMENT, Le Quartz,
75 Cours Emile Zola, 69100 Villeurbanne/Lyon - France

SALES CONTACTS

- North America - Steve Laferriere: +13106 008 267
laferriere@yole.fr
- Europe & RoW - Lizzie Levenez: + 49 15 123 544 182
levenez@yole.fr
- Japan & Rest of Asia - Takashi Onozawa: +81 3 6869 6970
onozawa@yole.fr
- Greater China - Mavis Wang: +886 979 336 809
wang@yole.fr
- Specific inquiries: +33 472 830 180 – info@yole.fr

⁽¹⁾ Our Terms and Conditions of Sale are available at
www.yole.fr/Terms_and_Conditions_of_Sale.aspx
The present document is valid 24 months after its publishing date:
November 20, 2017

PRODUCT ORDER - REF.YDPEI705I

Please enter my order for above named report:

One user license*: Euro 5,490

Multi user license: Euro 6,490

- The report will be ready for delivery from November 29, 2017

- For price in dollars, please use the day's exchange rate. All reports are delivered electronically at payment reception. For French customers, add 20% for VAT

I hereby accept Yole Développement's Terms and Conditions of Sale⁽¹⁾

Signature:

*One user license means only one person at the company can use the report.

SHIPPING CONTACT

First Name:

Last Name:

Email:

Phone:

ABOUT YOLE DEVELOPPEMENT

Founded in 1998, Yole Développement has grown to become a group of companies providing marketing, technology and strategy consulting, media and corporate finance services, reverse engineering and reverse costing services and well as IP and patent analysis. With a strong focus on emerging applications using silicon and/or micro manufacturing, the Yole group of companies has expanded to include more than 80 collaborators worldwide covering MEMS and image sensors, Compound Semiconductors, RF Electronics, Solid-state lighting, Displays, software, Optoelectronics, Microfluidics & Medical, Advanced Packaging, Manufacturing, Nanomaterials, Power Electronics and Batteries & Energy Management.

The "More than Moore" market research, technology and strategy consulting company Yole Développement, along with its partners System Plus Consulting, PISEO and KnowMade, support industrial companies, investors and R&D organizations worldwide to help them understand markets and follow technology trends to grow their business.

CONSULTING AND ANALYSIS

- Market data & research, marketing analysis
- Technology analysis
- Strategy consulting
- Reverse engineering & costing
- Patent analysis
- Design and characterization of innovative optical systems
- Financial services (due diligence, M&A with our partner)

More information on www.yole.fr

MEDIA & EVENTS

- i-Micronews.com website and related @Micronews e-newsletter
- Communication & webcast services
- Events: TechDays, forums,...

More information on www.i-micronews.com

REPORTS

- Market & technology reports
- Patent investigation and patent infringement risk analysis
- Teardowns & reverse costing analysis
- Cost simulation tool

More information on www.i-micronews.com/reports

CONTACTS

For more information about :

- Consulting & Financial Services: Jean-Christophe Eloy (eloy@yole.fr)
- Reports: David Jourdan (jourdan@yole.fr) Yole Group of Companies
- Press Relations & Corporate Communication: Sandrine Leroy (leroy@yole.fr)