



DIGITAL FORENSIC RESEARCH CONFERENCE

Forensic Analysis of Water Damaged Mobile Devices

By

Aya Fukami and Kazuhiro Nishimura

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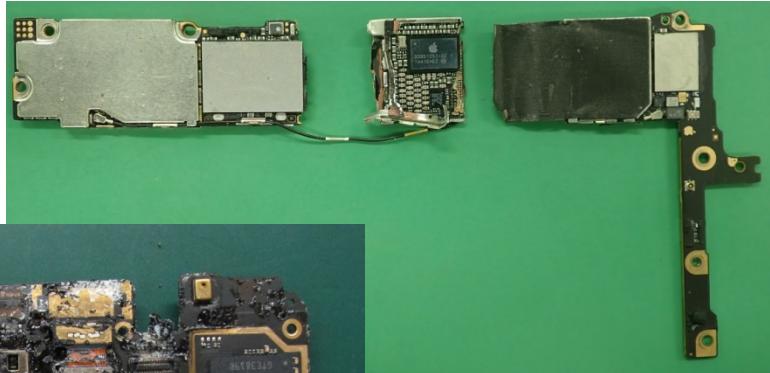
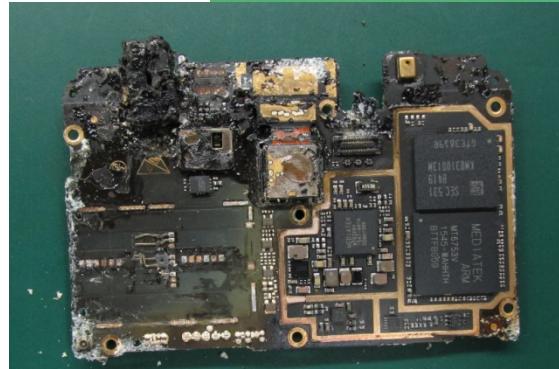
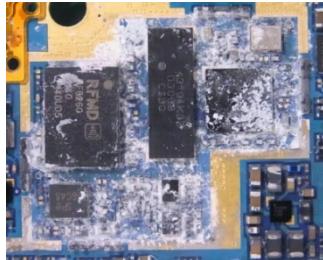
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Data Recovery from Damaged Devices

- Physical damage
- Fire damage
- Water damage



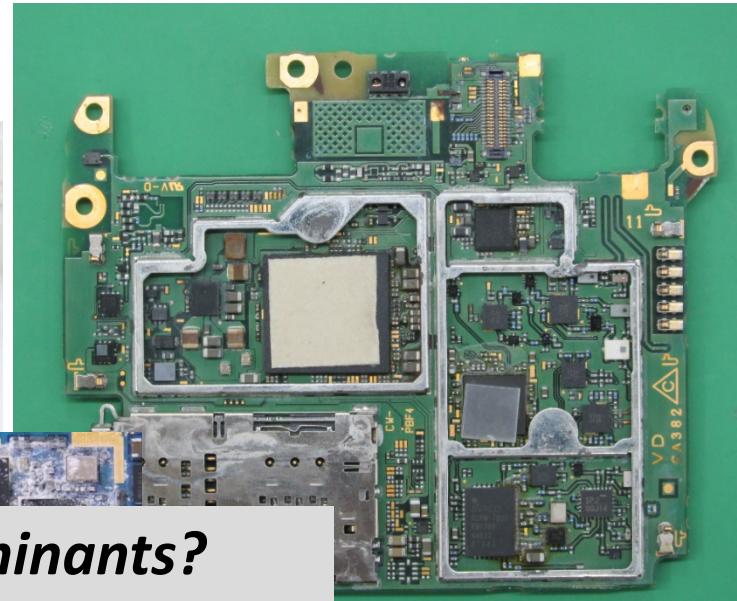
*Data recovery is possible through **chip transplant** as long as the key components are undamaged*

How We Receive Water Damaged Devices (In reality)

- Transported in liquid or in a dried state

(after being left at a police station for a few days ...)

- Disassembling
- PCB cleaning
- Drying



*What are those white contaminants?
Chip transplants really necessary?*

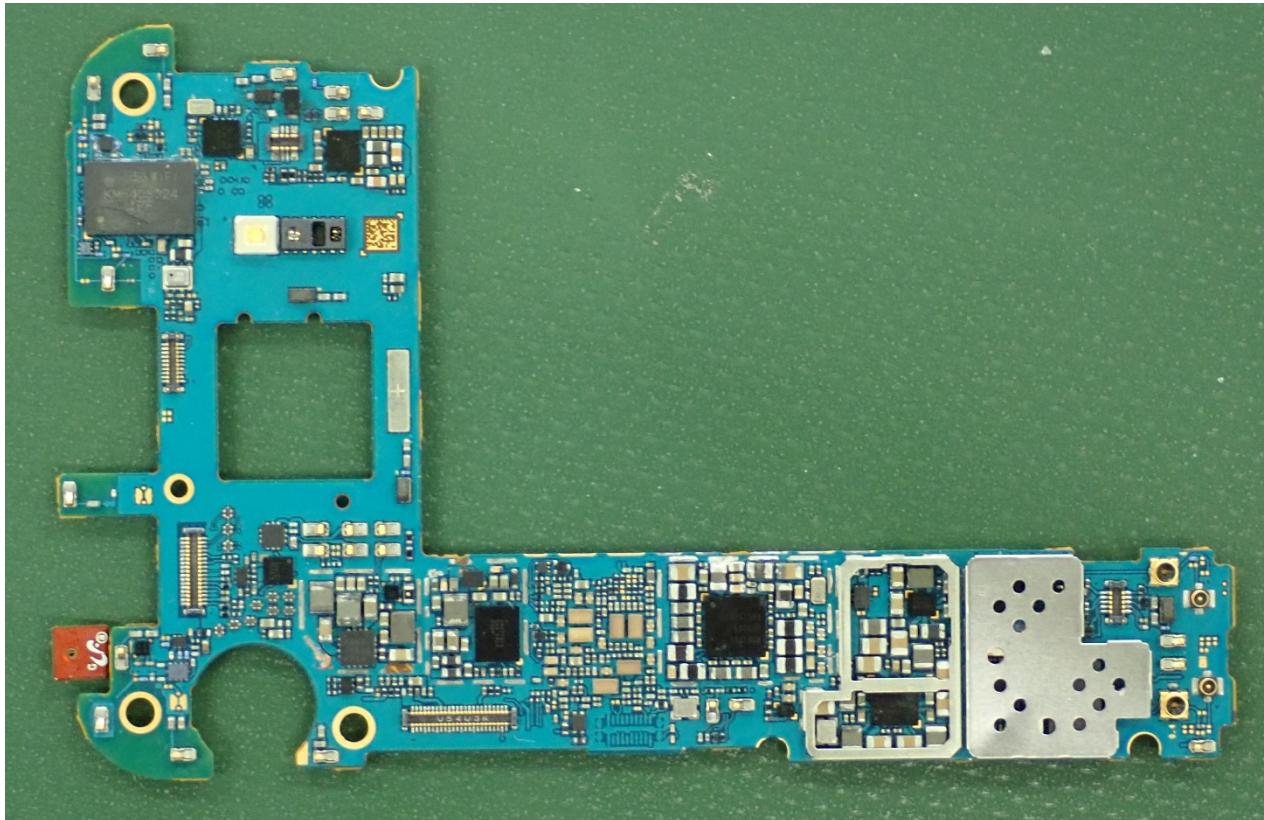
Brief Summary of the Paper

- *Our Goal:*
 - Understand the board level reaction when a mobile device contacts with liquid
 - Update the forensic handling method for water damaged devices to improve successful data recovery
- *Our findings:*
 - Metal corrosion is the key about water damaged devices
 - Longer submersion time leads to more severe corrosion

Talk Outline

- Metal corrosion under humid environment
 - Electrochemical migration (ECM)
 - Galvanic corrosion
- Testing water damage to smartphones
 - Observing system failure of water-submerged smartphones
 - Repairing water damaged smartphones
- Conclusion

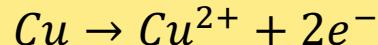
Smartphone Main Board



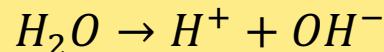
Metal Corrosion by Electrochemical Migration

Anodic reaction

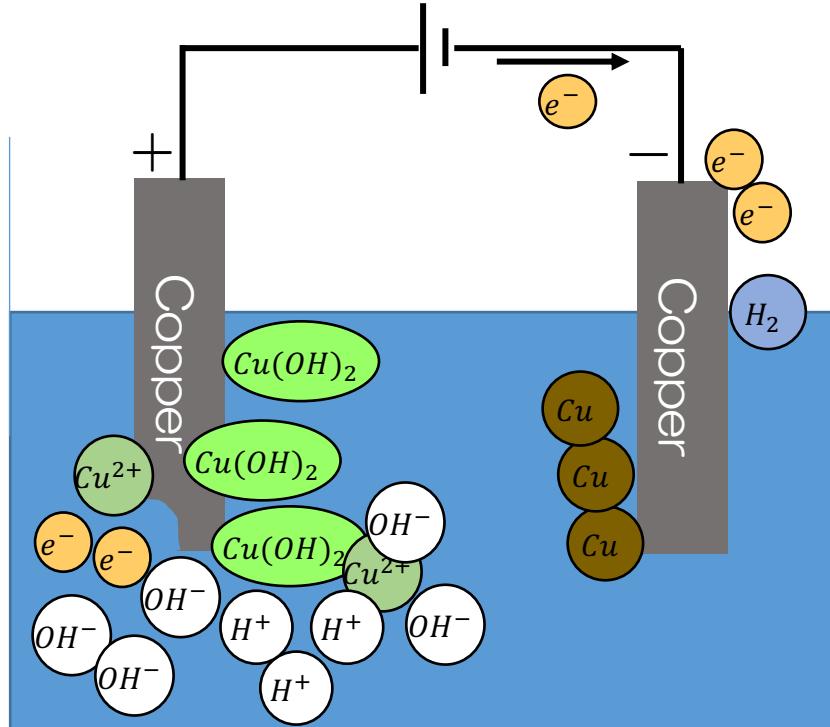
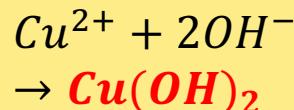
Metal ionization



Water



Precipitation of
Copper hydroxides



Cathodic reaction

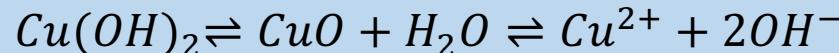
Copper deposition



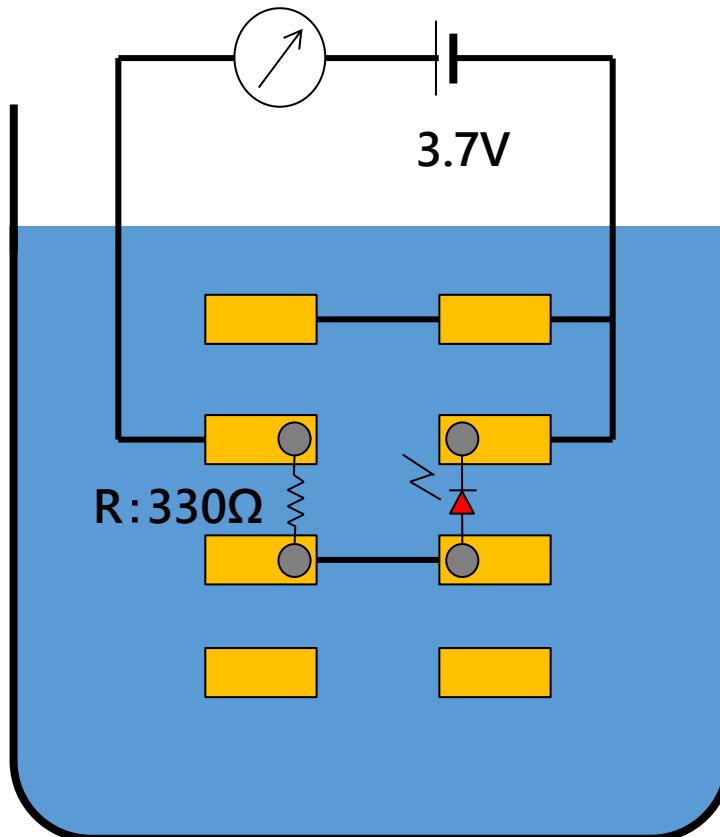
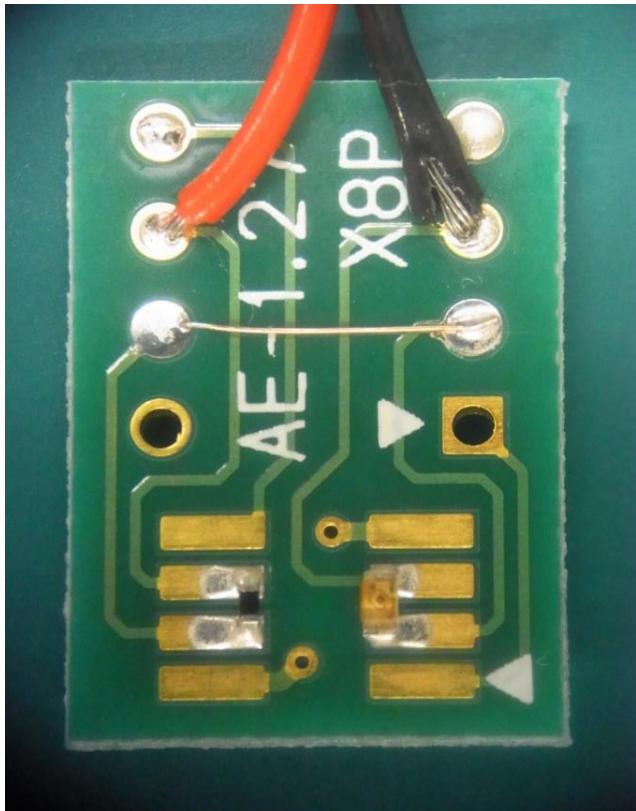
Hydrogen production



Inter-electrode reaction

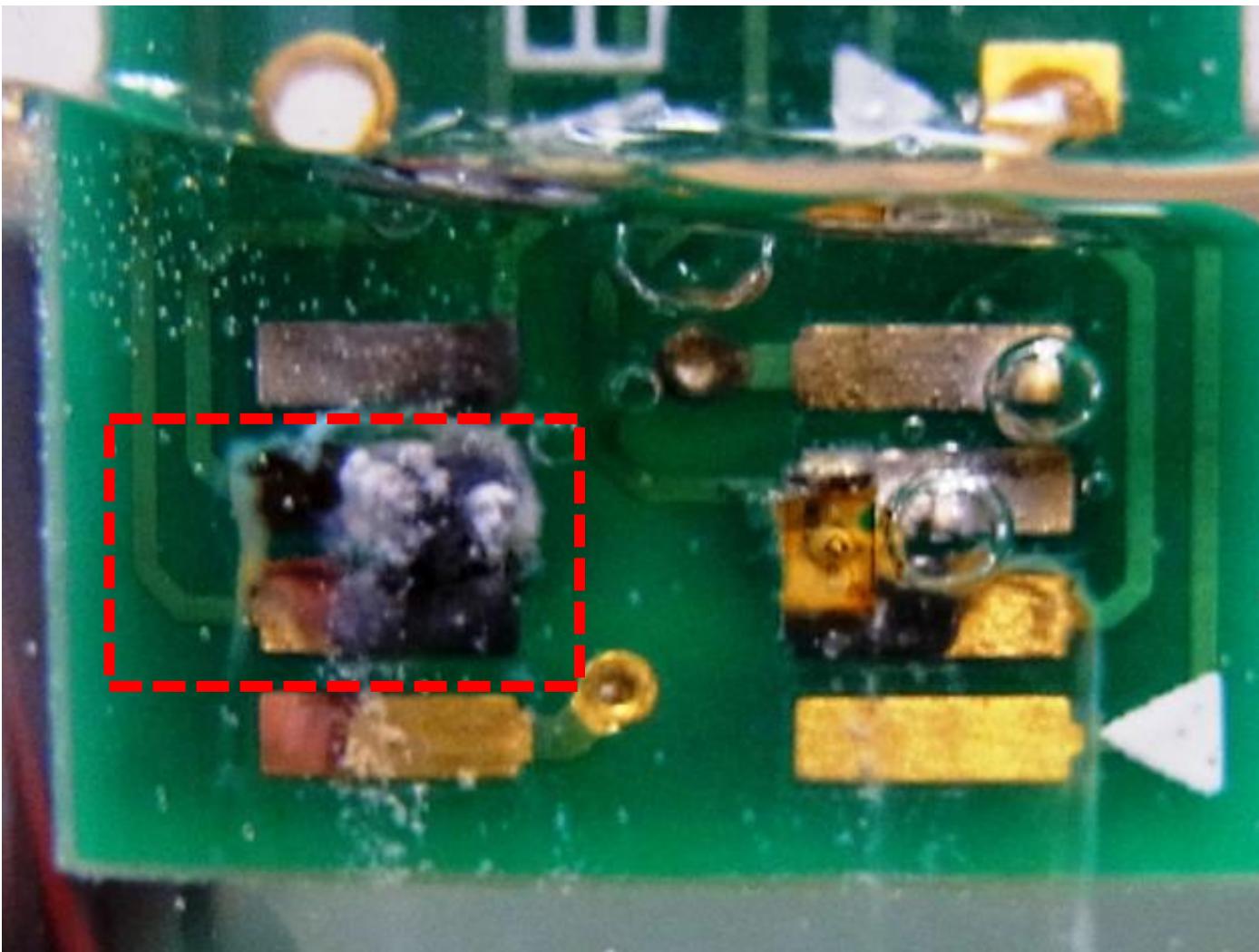


Electrochemical Migration (ECM)

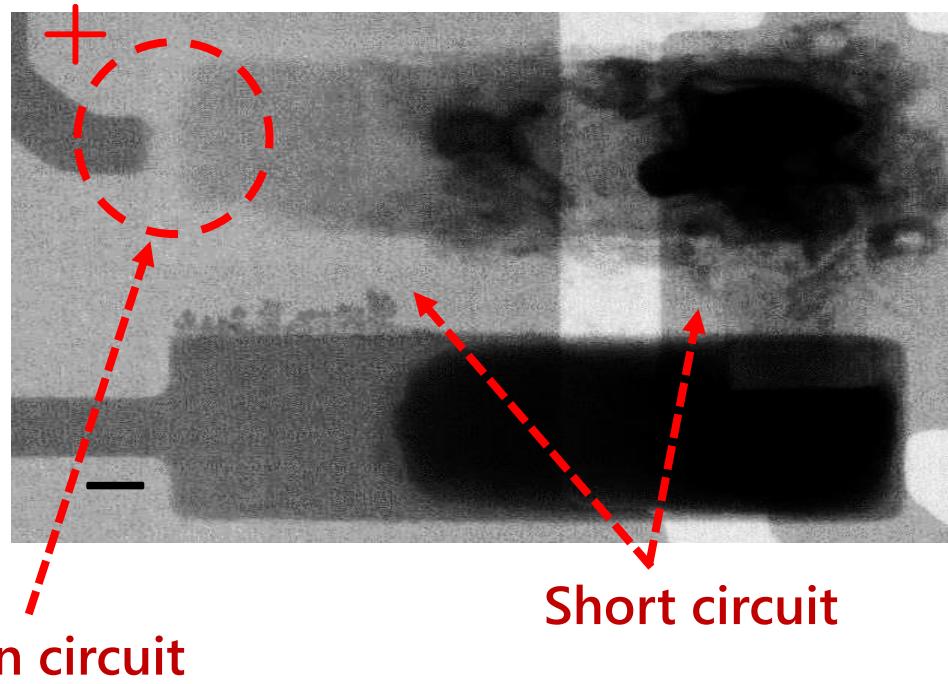








Metal Corrosion by ECM

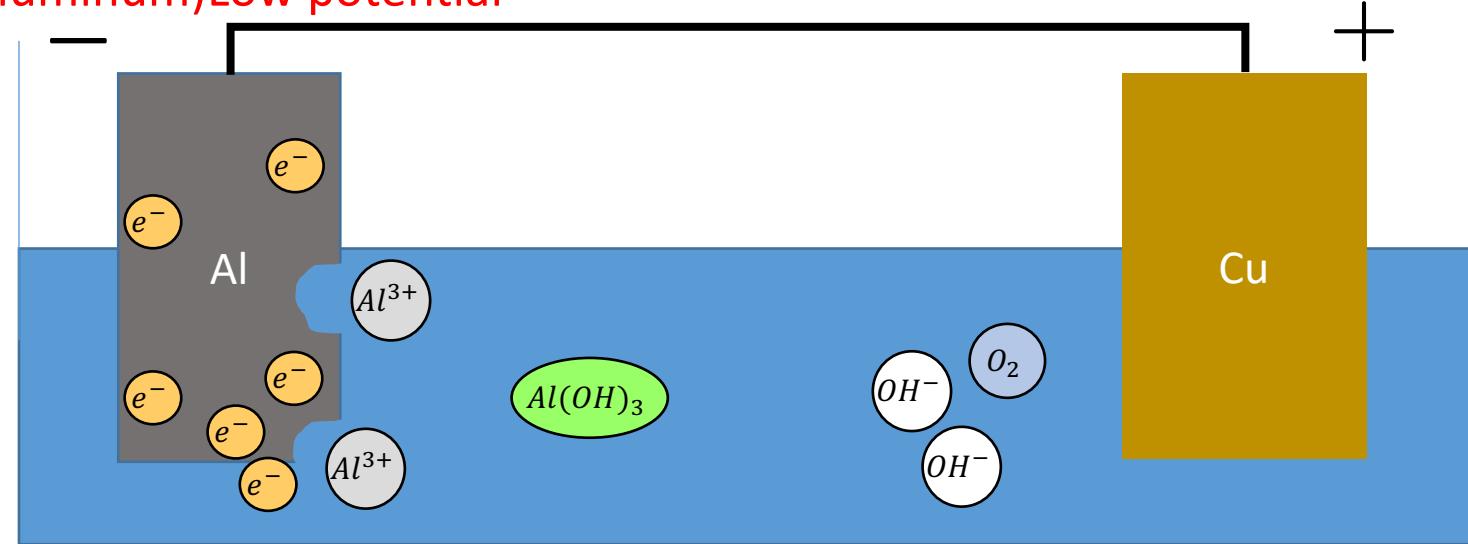


Open circuit

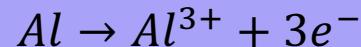
Short circuit

Galvanic Corrosion

Less noble metal
(i.e., Aluminum) Low potential

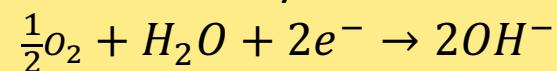


Aluminum ionization



Noble metal
(i.e., Copper) High potential

Water electrolysis



Galvanic Corrosion - Example



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Testing water damage on Smartphones

- Samsung Galaxy 6s Edge & LG Nexus 5X
 - Two each, one submerged while running, another while turned off
 - Battery fully charged
 - Left in tap water for three days

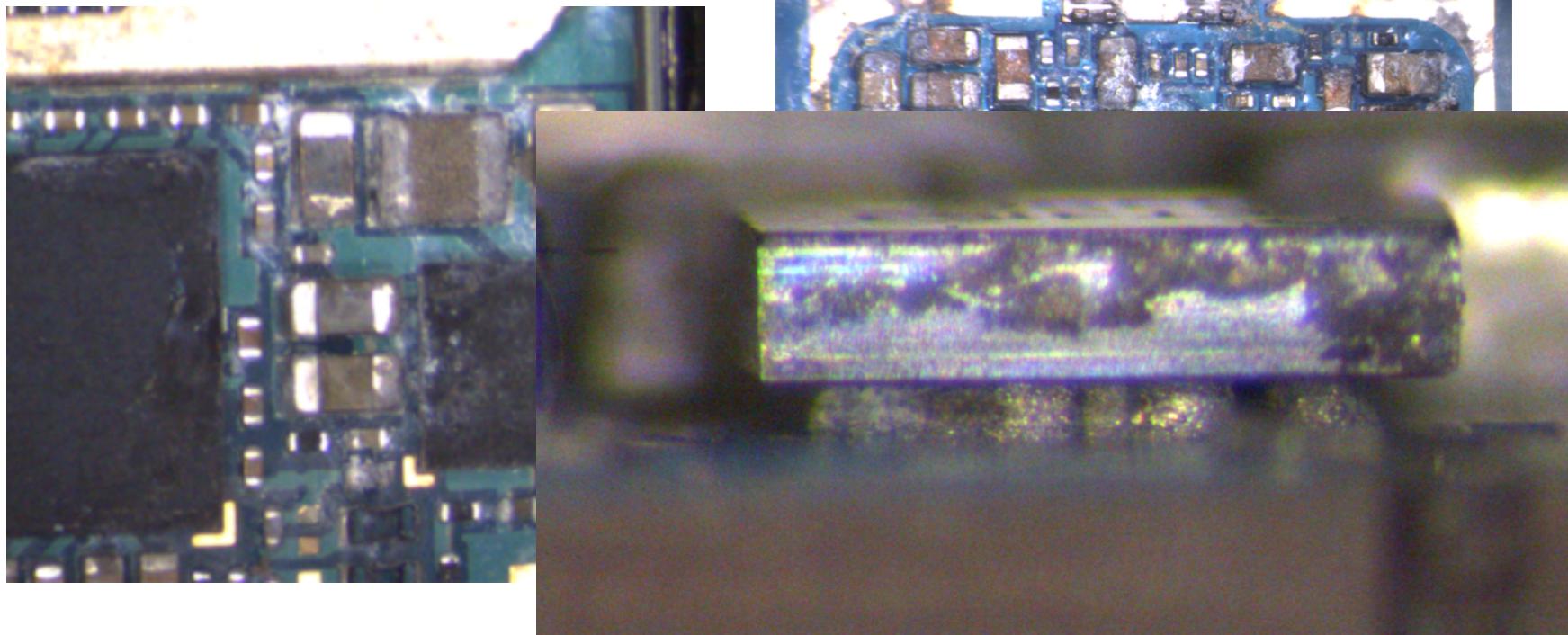


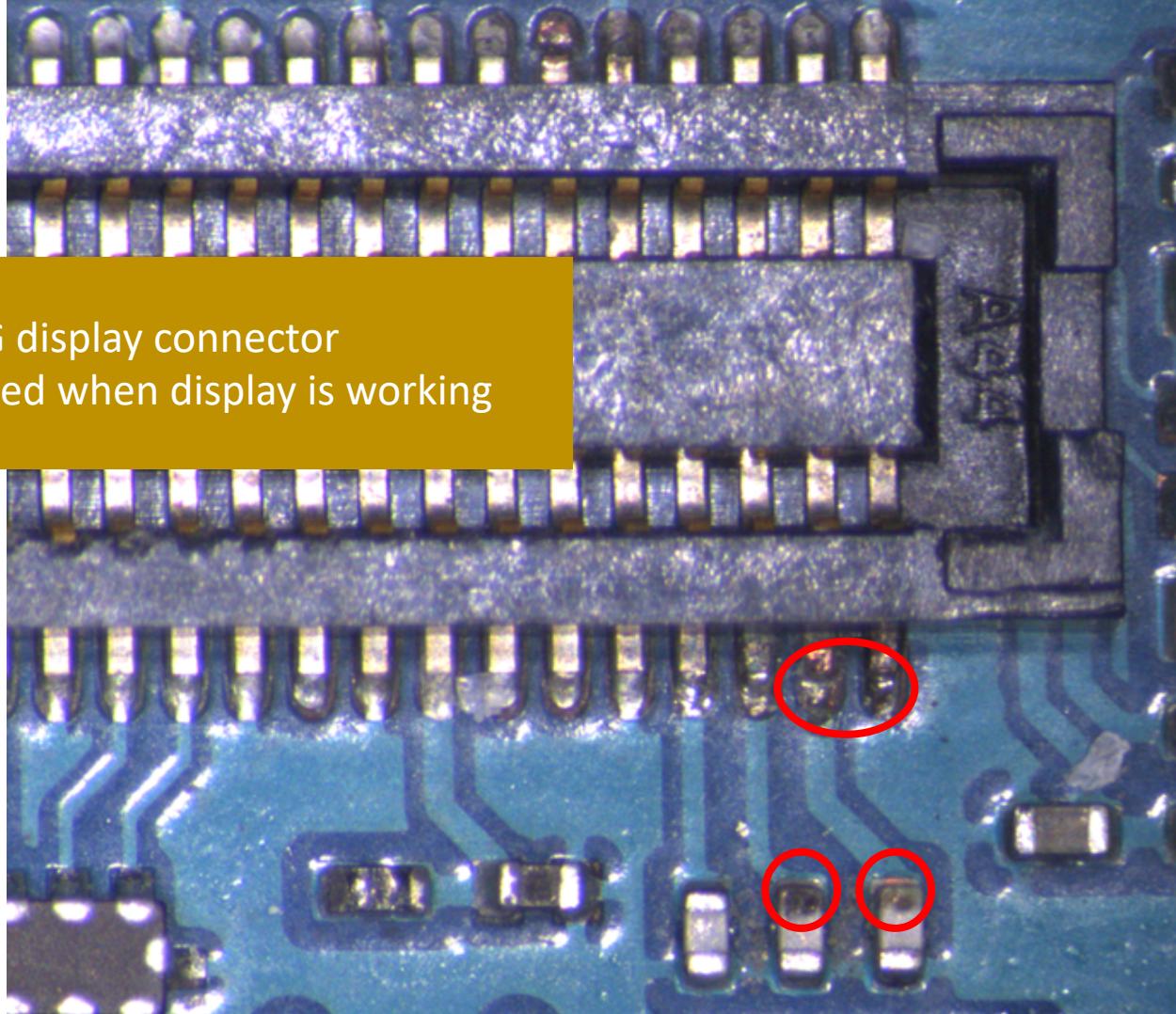
Results

After being dried and PCB cleaned

	Samsung S6 edge	LG Nexus 5
Turned on	PMIC damaged, swap needed	Display connector corroded
Turned off	PMIC short circuited no swap needed	No repair needed after cleaning

Results

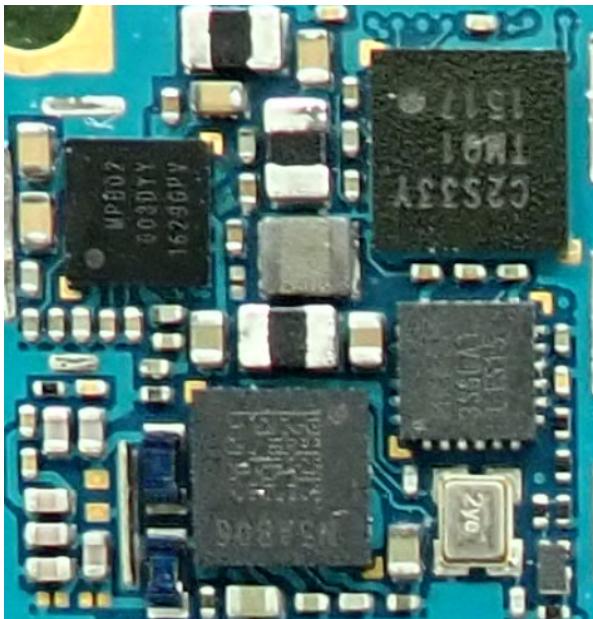




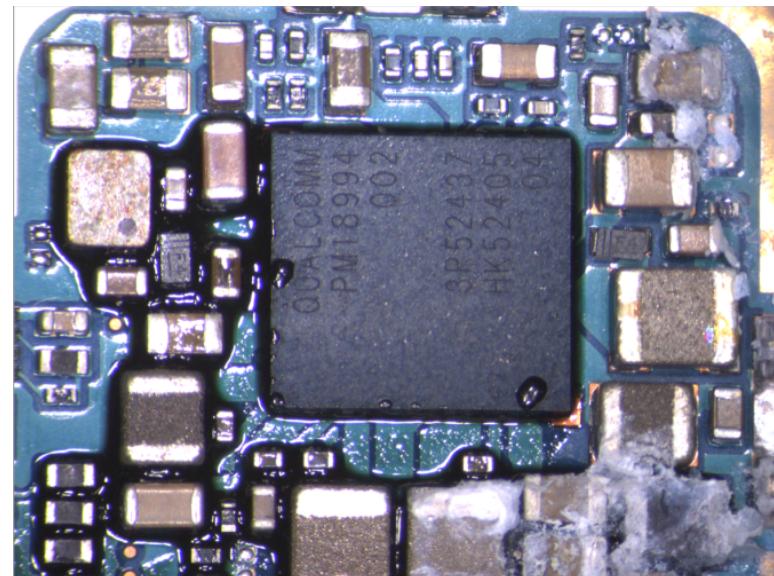
LG display connector

~20V applied when display is working

LG Devices: Underfill protected

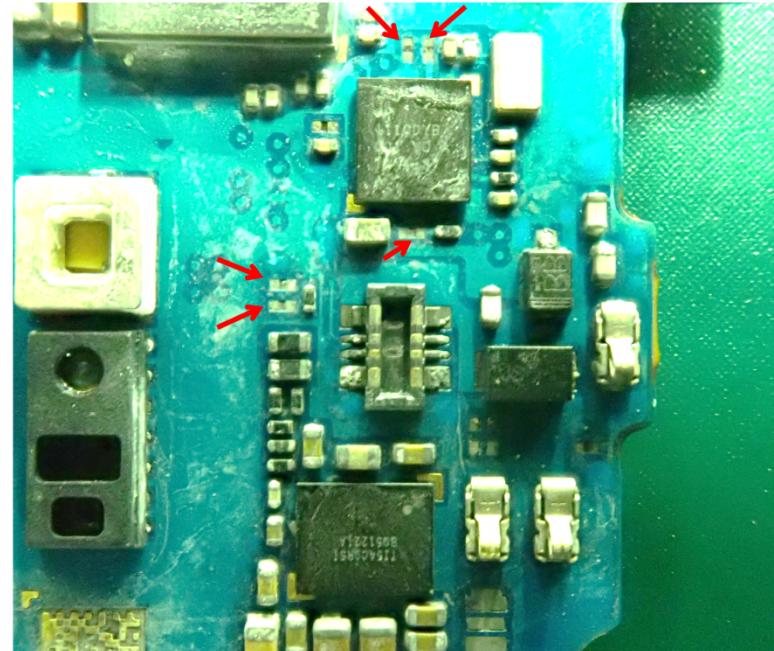
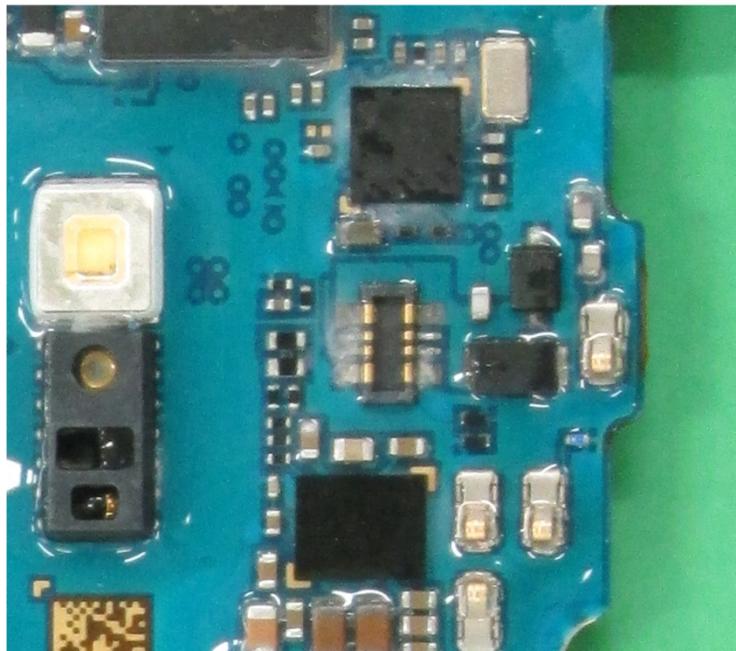


Samsung: no underfill



LG: Underfill protected²¹

Metal Corrosion and Missing Components by Galvanic corrosion



Longer submersion time = severe corrosion = detachment of components

Conclusions

- Water damage = Metal corrosion (ECM/Galvanic)
= System failure
- Corrosion severity factors
 - Liquid conductivity
 - Submersion time
 - Exposure of metal
 - State of the device
 - Voltage level
- Proper knowledge about water damage helps successful data retrieval



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