KEEPING SMART PHONES PROTECTED

By designing in features to protect from potential causes of failure, more sustainable value can be created in these expensive, subsidized handsets.

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The smart phone is quickly becoming the most ubiquitous consumer electronics device. Recent research shows that half (54.9 percent) of U.S. mobile subscribers own a smart phone, and that growth is forecast to continue unabated.[1] Data usage is increasing dramatically. Smart phones already represent over 82 percent of global handset traffic.[2]

Today's smart phones are increasingly complex wireless devices with ever-expanding functionality. They are being used by more and more people every day for longer periods of time in an expanding diversity of operational conditions. Smart phones are used for texting, e-mail, instant messaging, internet, cameras, GPS, watching movies and even watching TV. Oh, and you can make phone calls on them, too.

Consumers want all the latest features, insist on high quality sound, and expect reliable performance regardless where and how they use the device. The trend toward increasingly complex devices that can function in any kind of environment increases the need for more durable protection. And, from a design perspective, it also means that every millimeter of the space inside the housing is at a premium.

Environmental/ Durability Risks

The demands on these devices continue to escalate, exposing them to increased risk of damage from exposure to liquids, particulates, temperature, pressure, and corrosion. In fact, three percent of all smart phones are ruined within 12 months of being sold, due to liquid exposure. [3]

The acoustic openings in smart phones—microphones, receiver and speaker—can be a source of problems if not adequately protected. ***See Figure 1.*** Smart phones need to be protected from challenging conditions like being exposed to rain or spilled coffee, being dropped in the sand at the beach, and the dust and dirt present all around us. If the acoustic transducers aren't protected, sound quality can diminish, and the device can ultimately fail.

Smart Phone Component Failure

Through continued testing to identify the major causes of smart phone component failure, Gore has identified several distinct problem areas—water, temperature, pressure and corrosion—that require protection against. Features such as increased data usage, touchscreens, high-resolution cameras, multiple acoustic transducers and electromechanical components such as enclosure gaskets and flex connectors have considerably increased the challenge to long-term smart phone reliability. Typical causes of failure in these components are:

- Malfunction due to environmental conditions
  - Water and particulate ingress through ports and connectors
  - Dust, dirt and metal particles
  - Electrostatic discharge

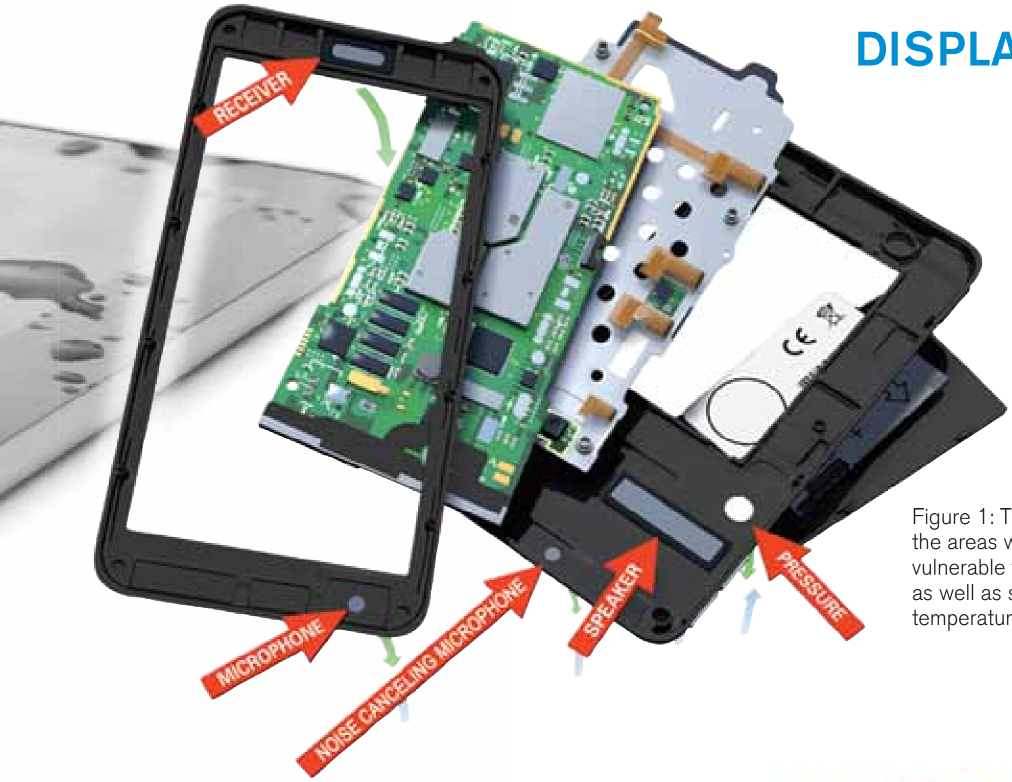


Figure 1: This exploded view shows the areas where a smart phone can be vulnerable to particulate and liquid ingress, as well as sudden variations in pressure and temperature.

- Operation malfunction from pressure differentials caused by change in temperature and/or altitude
  - Bulging keypads and screens
  - Permanent bias on transducers
- Mechanical failure
  - Shock due to accidental drop
  - Repetitive cycling fatigue
- Poor or degraded sound quality
  - Liquid and particle ingress
  - Wind noise
  - Loose metal particles on cone
  - Acoustic design

Addressing the Problems

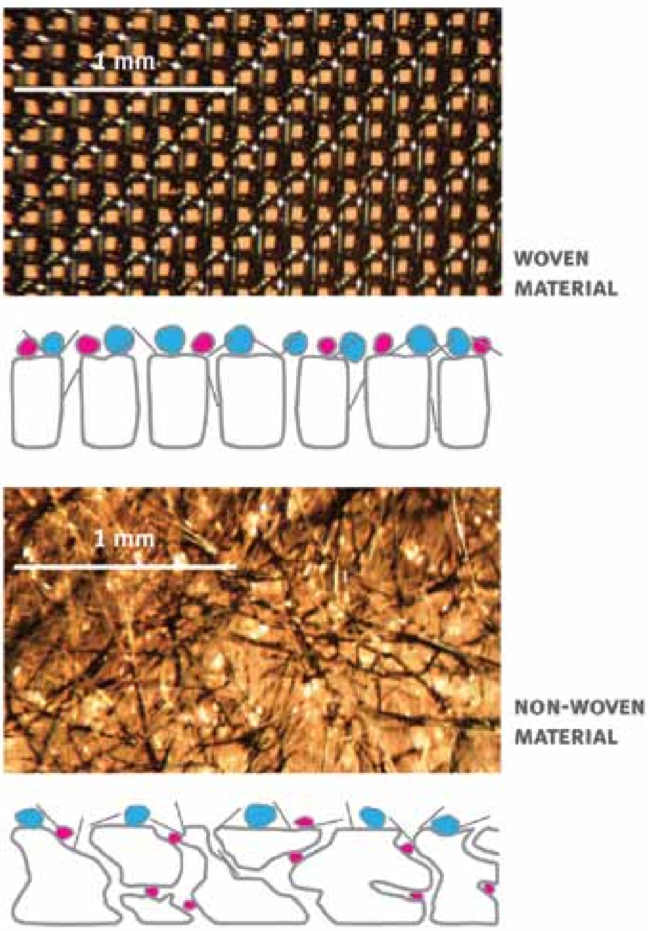
Let's talk about one of the most common problems: getting a phone wet. A smart phone can be affected by the rain, just one of the many "oops" that frequently happen. That can be a killer without adequate protection over the acoustic openings. Although waterproof transducers can prevent water from entering sensitive sections of devices, they can still allow water and particulates onto and around the transducer surface. If covered with a protective mesh material, the electronics inside the housing may be exposed to damage from contaminants. If these transducers are covered with a non-porous material, pressure can build on the transducer diaphragm. This pressure buildup reduces the transducer's ability to vibrate in order to reproduce sound waves accurately.

Transducer Bias

In portable electronics that use waterproof transducers, internal pressure changes can affect a sealed device's performance. Pressure differentials occur primarily because of one of two environmental changes: rapid temperature changes such as when the device is taken from a warm car into cold weather outside, or air pressure changes such as during takeoff or landing of an aircraft. As pressure builds in an acoustic cavity or chamber, it creates a bias on compliant surfaces of the transducer, such as speaker and/or receiver diaphragms. This effect can reduce acoustic output and eventually damage the transducer.

Protecting the Phone —Why Vents?

OEMs may address these problems by installing a pro-



Woven material (top) captures particles equal to or greater than its specified pore size, whereas non-woven materials (bottom) capture a greater range of particle sizes and shapes.

tective mesh over the acoustic openings. This mesh is generally selected based on the minimum particle size to be prevented from entering.

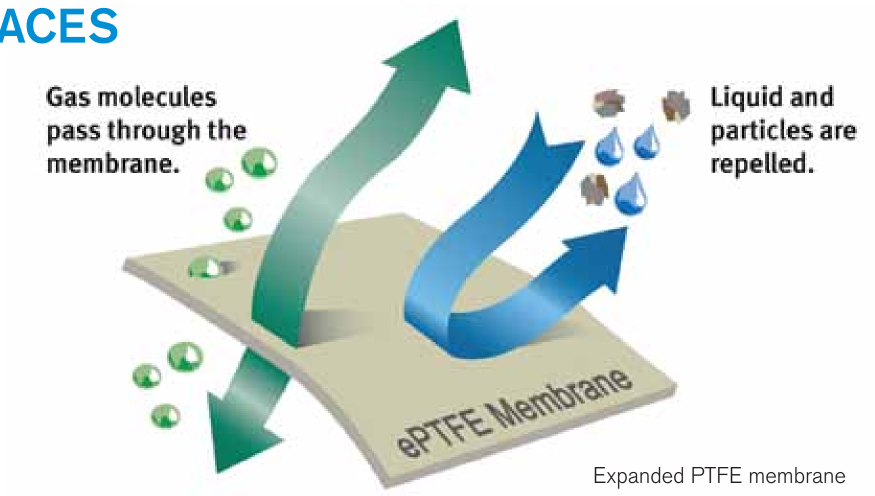
However, just selecting a material based on particle size does not address the entire problem. And smart phones are evolving so rapidly—the vast majority of components in current-generation smart phones are recent additions—that OEMs have to be careful not to design to yesterday's standards, which do not adequately safeguard reliable performance.

Current solutions often do not go far enough. Vents designed specifically for portable electronics with acoustically transparent materials that create a barrier against external elements and everyday liquids while equalizing pressure inside the housing—and maintaining acoustic performance—need to be engineered in at the initial design stage.

For protection from liquids, even with the use of waterproof transducers, maintaining high-quality acoustic performance requires pressure vents. They provide protection without compromising sound quality and release pressure from devices to prevent the transducer bias discussed above. Incorporating a vent in the housing allows air to flow freely, equalizing pressure within the housing and eliminating transducer bias.

Many device manufacturers simply specify a maximum pore size. However, in-house testing has shown that understanding the particle shape and surface area has a more direct impact on the level of protection a material can provide than considering size alone. Because woven material has uniform pore size—as defined by the width of the open square between fibers—the woven is able to capture only spherical particles equal to or greater than the material's defined pore size. In addition, captured particles sit on the surface, which can block airflow and reduce venting capability.

Particles such as human hair or metal fibers that have a surface area equal to or larger than the specified pore size can still pass through the woven material because of their shape.



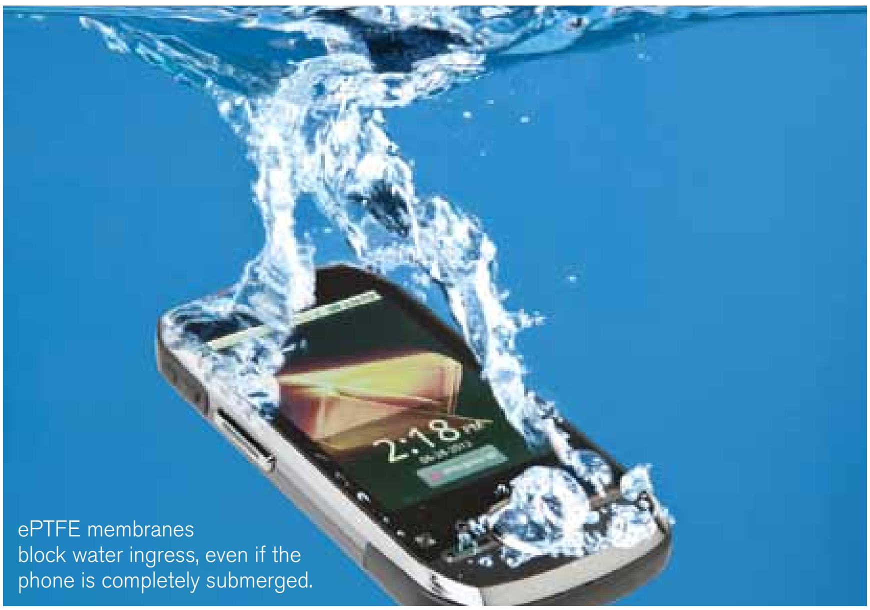
Expanded PTFE membrane

The Materials—Woven versus Non-Woven

Using specially developed test methods and in-house environmental testing facilities, companies have been able to demonstrate that non-woven materials are able to capture particles of various shapes and sizes because of their three-dimensional structure. They are also more likely to maintain consistent airflow because they capture particles in a tortuous path not limited by a specific pore size. Vents made from this material protect sensitive electronics from contaminants while also allowing the enclosure to breathe in order to avoid damage or device failure caused by pressure differences between the internal device and ambient conditions.

ePTFE

At present, non-woven materials may provide sufficient protection for most situations. However, as smart phones continue to evolve in complexity and value, so will the level of protection required to ensure reliable performance. That is why Gore developed vents using expanded polytetrafluoroethylene (ePTFE) membranes, which have a node-and-fibril construction that allows gas molecules (air) to pass through while completely repelling water and solid particles. Whereas non-woven materials capture fine particles, ePTFE membranes have microscopic pores that block virtually all particles in various shapes and sizes. These membranes respond quickly and easily to a sound wave, with the vibration of the membrane converting the airborne energy to mechanical vibrations. These vibrations are then reproduced on the other side of the membrane, creating high-quality sound with 100 percent waterproof protection—from light rain to complete immersion. This material is extremely thin, down to 0.24 mm or less depending on the type and application, which maximizes valuable housing space. It is also versatile enough to be provided in pre-cut shapes and sizes based on common industry speaker, receiver, microphone and enclosure dimensions. ■



ePTFE membranes block water ingress, even if the phone is completely submerged.

References:

1. *Neilsen Mobile Insights, June 2012*
2. *Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2011—2016. February 2012*
3. *SquareTrade Research Brief. Smart phone Reliability, November 2010*