# Enhanced ceramics could play pivotal role in advancing 5G technology

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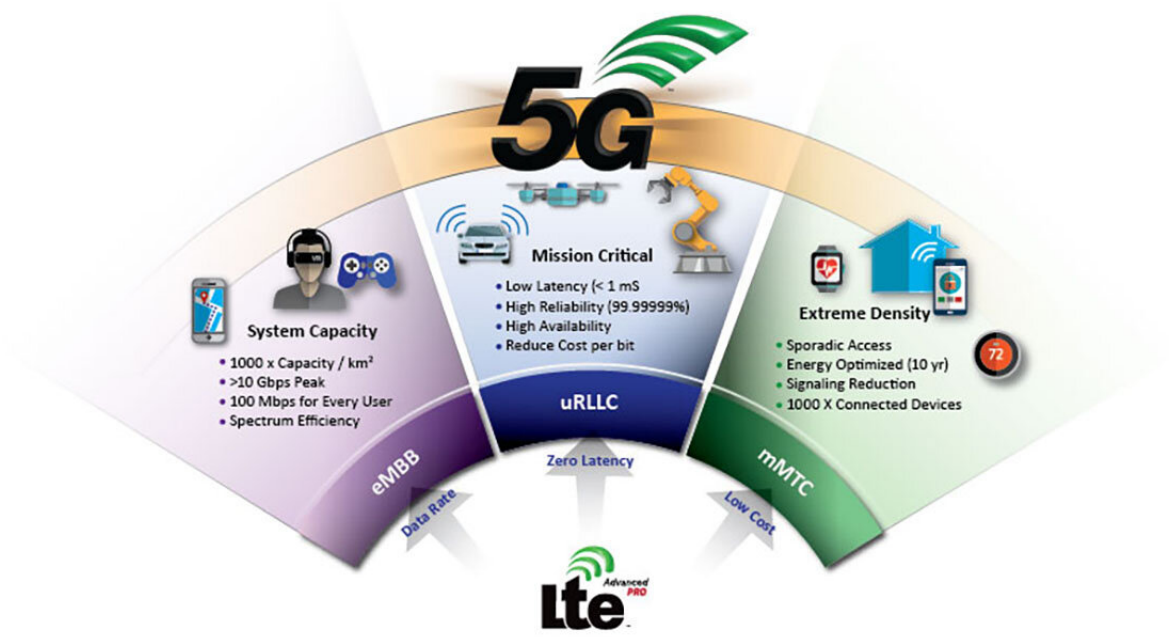


Advantages of 5G systems. Credit: Skyworks Solutions

5G, or the fifth-generation technology standard for broadband cellular networks, is touted as having finally arrived for ultrafast download speeds, an end to dropped calls and buffering, and greater connectivity to advance autonomous vehicle development, remote surgery, and the Internet of Things.

In truth, 5G technology adoption is still in its early stages, according to Michael Hill, technical director of Skyworks Solutions, a California-based advanced-semiconductor company. In their paper, published in *Applied Physics Letters*, Hill and his colleagues provide an overview on nascent 5G technologies and show how enhancing ceramic materials could play a pivotal role in 5G development.

5G operates in two frequency bands: 3-6 gigahertz for long-distance links and a much higher frequency band in the millimeter wave region (20-100 GHz) for ultrafast data speeds.

Accommodating the lower frequency band, closer to the 4G spectral regions, is less problematic than the significant changes needed to fully realize 5G capability in the higher frequency ranges. For example, frequency type is tied to overall signal strength. The higher the frequency, the shorter the distance the wave can travel.

Ceramic materials have long been used in wireless communications network technologies for both mobile devices and base stations. Enhancing ceramics, therefore, has been a central focus in improving 5G capability. For their part, Hill's research group has developed a ceramic to enhance a device that is critical for 5G applications, called a circulator.

Typically made of insulating ceramic materials based on yttrium iron garnet, circulators are three-port devices that serve as traffic circles to keep the signal flowing in one direction and enable a receiver and a transmitter to share the same antenna.

To significantly increase the energy density to accommodate the higher frequencies, the researchers have partially replaced yttrium with bismuth, a heavy element that increases the dielectric constant of the ceramic. The bismuth substitutions also enable the miniaturization of

circulators.

As the 5G technology battle continues to heat up, circulators could be supplanted by high-power gallium nitride-based switches, which shows just how early the stage still is for 5G technology development.

"Millimeter-wave technology is likely to be the wild west for some time, as one technology may dominate only to be quickly supplanted by a different technology," Hill said.

**More information:** "Perspective on ceramic materials for 5G wireless communication systems" *Applied Physics Letters* (2021). aip.scitation.org/doi/10.1063/5.0036058

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