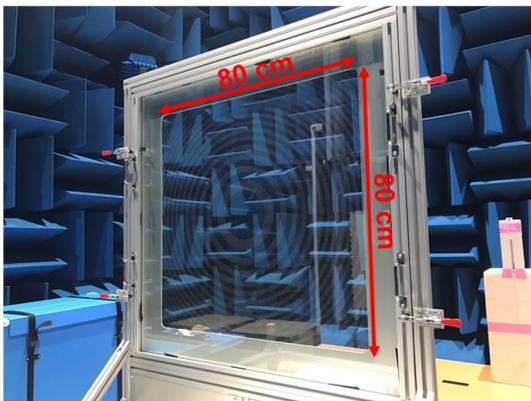


Joint Press Release—for immediate release

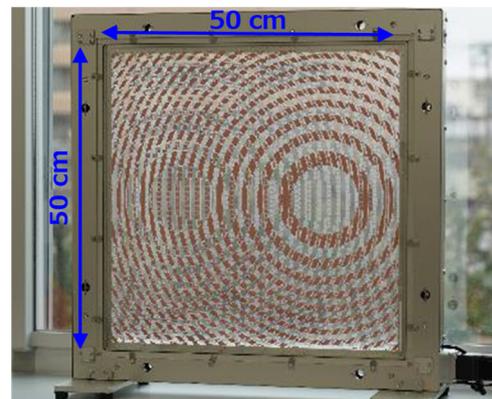
DOCOMO and AGC Use Metasurface Lens to Enhance Radio Signal Reception Indoors

— New technology efficiently guides millimeter waves to target locations indoors —

TOKYO, JAPAN, January 26, 2021—NTT DOCOMO, INC. and AGC Inc. announced today that they have developed a prototype technology that efficiently guides 28-GHz 5G radio signals received from outdoors to specific locations indoors using a film-like metasurface lens that attaches to window surfaces. DOCOMO and AGC also conducted what is believed to be world's first successful trial to direct 28-GHz signals passing through a window to specific locations indoors as well as raise the strength of the signals.



Static metasurface lens

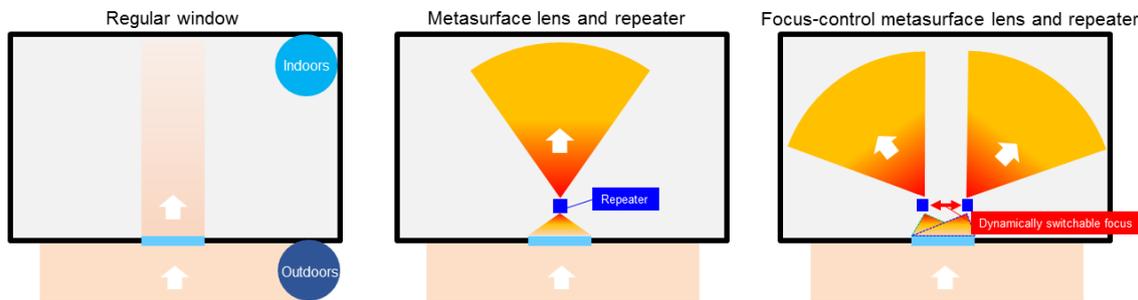


Dynamic metasurface lens

Newly emerging 5G networks as well as 6G networks of the future are expected to use high-frequency radio waves, such as 28 GHz. Although high-frequency signals enable the realization of advanced communication standards, they are subject to high attenuation over long distances and their high directivity resulting in low diffraction (or weak bending around objects) generally limits their range to within the line of sight of the transmitting base station. Consequently, it is difficult for high-frequency radio waves to penetrate windows, and even if they do they are attenuated to the point of not being able to propagate sufficiently to establish wireless communication links indoors.

The new metasurface lens is made with an artificially engineered material featuring a large number of sub-wavelength unit cells arranged periodically on a two-dimensional surface. Elements arranged in various shapes on the metasurface substrate can be attached to a glass window to direct radio signals to specific points (“focal points”) indoors. It is believed that radio waves from an outdoor base station could be received on a window’s broad surface and then efficiently propagated to specific focal points inside a building with the help of repeaters and reflectors.

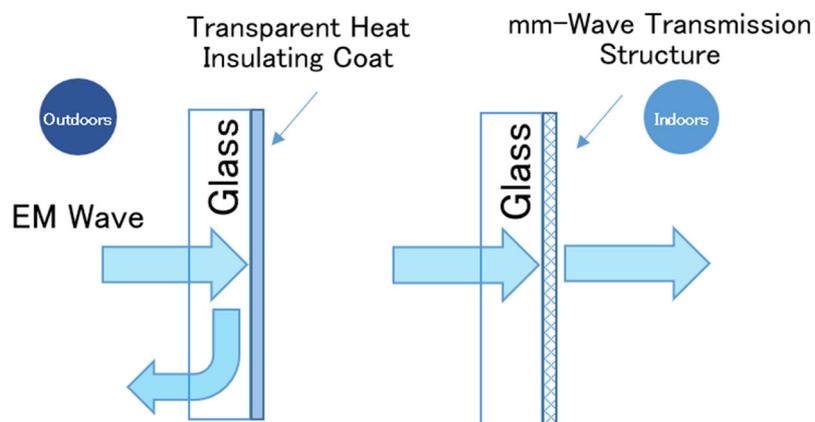
The metasurface lens material is a transparent film that can cover virtually the entire inside surface of a window. The material has no effect on LTE and sub-6 band radio waves, so it can be used to improve indoor reception of 28 GHz radio signals without affecting the performance of legacy wireless frequencies.



Scheme of metasurface lens

The trial confirmed that the metasurface lens improves the power level of 28 GHz radio signals received at indoor focal points. The trial also confirmed the ability to control focal-point position as well as the ability to switch from single to dual focal points.

In addition, DOCOMO and AGC verified that structural design technology can be deployed to enable metasurface lenses to allow high-frequency radio signals to penetrate glass that has been coated for heat insulation.



mm-wave transmission structure of glass coated for heat insulation

DOCOMO and AGC have been developing transparent metasurface technology for use in solutions that not only improve access to high-frequency radio signals but also are aesthetically acceptable. The new metasurface lens incorporates DOCOMO's metasurface design technology and AGC's design and microfabrication technologies.

The prototype metasurface lens will be presented during DOCOMO Open House 2021, which will take place online this February 4 to 7.

Going forward, DOCOMO and AGC will continue to collaborate in the research and development of technologies for highly efficient and flexible 5G and 6G wireless communication.

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About NTT DOCOMO

NTT DOCOMO, Japan's leading mobile operator with over 80 million subscriptions, is one of the world's foremost contributors to 3G, 4G and 5G mobile network technologies. Beyond core communications services, DOCOMO is challenging new frontiers in collaboration with a growing number of entities ("+d" partners), creating exciting and convenient value-added services that change the way people live and work. Under a medium-term plan toward 2020 and beyond, DOCOMO is pioneering a leading-edge 5G network to facilitate innovative services that will amaze and inspire customers beyond their expectations. www.nttdocomo.co.jp/english.

About AGC Inc.

AGC Inc. is the parent company of the AGC Group, a world-leading glass solution provider and supplier of flat, automotive and display glass, chemicals, ceramics and other high-tech materials and components. Based on more than a century of technical innovation, the AGC Group has developed a wide range of cutting-edge products. The AGC Group employs some 55,000 people worldwide and generates annual sales of approximately 1.5 trillion Japanese yen through business in about 30 countries. For more information, please visit www.agc.com/en