

# Metamaterial Smart Reflector

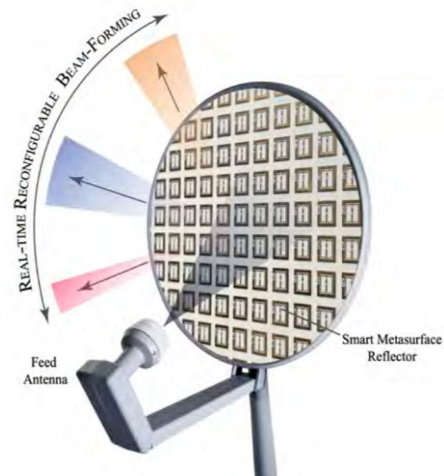
## Background

To support the increased demand in data capacity for 5G and beyond wireless networks, current efforts are focused on migrating towards higher frequency bands, including millimeter-waves (typically 24 GHz onwards). Near-directive 5G communications can exploit the paradigm shifting concept of engineering the radio environment to consciously manipulate and distribute the EM power to desired destinations. To this end, Carleton's **Metamaterial Smart Reflector** can be installed in strategic areas of a given radio environment (e.g., ceilings, floors and other objects) and, in cooperation with fixed antenna sources and receivers, guide the EM power along preferred directions.

## Description of the Invention

Carleton researchers have developed and tested a novel metasurface that provides unprecedented control of the reflection characteristics of the surface. The architecture consists of a 2D array of unit cells each comprising electromagnetically coupled resonators. This novel unit cell configuration enables independent control of reflection phase and magnitude at the specified frequency, resulting in a smart software programmable reflector system scalable to various frequency bands.

*Concise Visual Summary* [here](#)

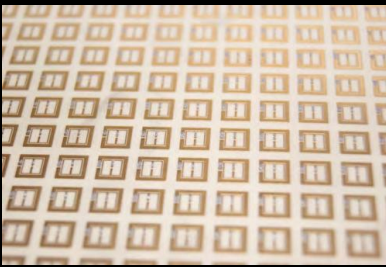


## Key Benefits

- **Real-time configurable and independent control** of magnitude and phase at desired frequency
- **Dynamic real-time control** row-by-row or a pixel-by-pixel
- **Scalable Architecture** ideal for sub-6 GHz Microwave Bands, X-Band, mm-Wave Bands
- **Integrated metasurface controller** to wireless communicate with a central control unit located elsewhere; capability to add AI/ML based software controls to respond to changes in the radio environment
- **Superior coverage and ultra high speed** can be gained in communications applications

## Applications

- **Communications:** Radio environment engineering for 5G short-range communication in indoor or dense urban areas; phased-array solutions for point-to-point links, satellite communication, tracking, wireless backhaul
- **Defense:** Electromagnetic camouflaging and radar spoofing



Surface with 2-D array of unit cells each comprising unique coupled resonator concept

## Inventors:

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## Development Stage:

Prototype Validation

## Protection Status:

US application (granted)  
CA application 3,196,718  
(filed Sept. 24, 2021)

## Publications

Emara et al., *IEEE Access*,  
vol. 11, pp. 129552-129565  
DOI:10.1109/ACCESS.2023.3333869

Macdonell at al., *IEEE Access*,  
vol. 13, pp. 65301-65315  
DOI:10.1109/ACCESS.2025.3555197

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