1. The Subject and Aims of Research
The main research interest is to develop the novel microwave components using the design concept of microwave metamaterials and to miniaturize microwave circuits. For development of microwave metamaterial components, the property of arbitrarily synthesizing the phase response is adopted to implement the metamaterial artificial transmission line with a specified phase response, and then applied to design novel microwave components. Our research group has successfully developed the broadband quadrature power splitter and balun, and then used them to implement the balanced amplifier, push-pull amplifier, circularly patch antenna, and image-reject mixer. For miniaturization of microwave circuits, the slow-wave artificial transmission line and multilayered low-temperature co-fired ceramic (LTCC) manufacturing process are exploited to reduce the circuit size for the requirement of compact personal wireless communication products.

2. Related Recent Research Topics
(a) Development of microwave metamaterial components: The “metamaterials”, also referred to as “left-handed materials”, are artificial guided-wave structures that can be designed to exhibit simultaneously negative permittivity ($\varepsilon$) and permeability ($\mu$). Since metamaterials have specific electromagnetic properties not commonly found in nature, in recent years, they are applied to develop the novel microwave circuits and applications. Our research group has successfully developed the quadrature power splitter and wideband balun, and then applied to design the broadband balanced amplifier and push-pull power amplifier, respectively (Fig. 1 and 2). In addition, the quadrature power splitter is also exploited to design circularly polarized patch antenna and image-reject mixer (Fig. 3).

Fig.1 The quadrature power splitter (left) and broadband balanced amplifier (right).

Fig.2 The wideband balun (left) and the push-pull power amplifier (right).
Development of microwave metamaterial components: Using integrated circuit process or low-temperature co-fired ceramic process is the effective approach to miniaturize the circuit size. Based on this concept, our research group has successfully developed the compact rat-race coupler using the multilayered low-temperature co-fired ceramic process (Fig. 4). In addition, our group also dedicates to implement a new slow-wave guided structure, shunt-stub-based artificial transmission line, and then applied to design compact planar rat-race coupler (Fig. 5). It demonstrates that using this approach can achieve significant circuit size reduction.

3. Selected Publications and Projects