**Active Microwave Metamaterials Incorporating Gain Devices**

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Metamaterials are artificial composite materials that can have special properties (e.g., negative index of refraction) that do not exist in nature. Many interesting and exciting applications such as “perfect” lens, cloaking device and electrically small antennas have been proposed. However, two fundamental problems – material loss and narrow bandwidth severely limit the realization of many proposed applications. Introducing active gain or negative impedance in a metamaterial can theoretically overcome the intrinsic loss and narrow bandwidth issues of passive metamaterials. First-time experimental demonstrations of 1-D and volumetric negative index structure with net gain will be presented. A refractive prism based on this structure is also simulated to validate the concept. These results have shown that active metamaterials can overcome the intrinsic limitations of loss and bandwidth and paved the way for potential realization of exciting devices such as “invisible cloak”. In addition, some examples of electrically small antennas based on active metamaterial concept will also be presented.



**Bio:** Dr. Hao Xin, Professor of Electrical and Computer Engineering at the University of Arizona. He is named an Arizona Engineering fellow in Aug. 2013. He joined University of Arizona since August 2005 as an assistant professor. He was promoted to tenured associate professor in 2009 and to full professor in 2012. He received his Ph.D in Physics from Massachusetts Institute of Technology in February 2001. From 2000 to 2003, he was a research scientist with the Rockwell Scientific Company. He was a Sr. Principal Multidisciplinary Engineer with Raytheon Company from 2003 to 2005.

His primary research interests are in the area of microwave / millimeter wave / THz antennas, devices, circuits and their applications in wireless communication and sensing systems. His recent research activities have covered a broad range of high frequency technologies, including applications of new technologies and materials in microwave and millimeter wave circuits such as electromagnetic band gap crystals and other meta-materials, carbon nano-tubes devices, solid state devices and circuits, active or semi-active antennas, and passive circuits. He has authored over 230 referred publications and 14 patents (13 issued and 1 pending) in the areas of microwave and millimeter-wave technologies, random power harvesting based on ferro-fluidic nano-particles and carbon nanotube based devices. His group’s work on active metamaterials have been published in prestigious journals including Physical Review Letters, Nature Communications, etc., and have received extensive media coverage (the story on the active metamaterial work received over 200 million hits). He is a senior member of IEEE and chair of the joint chapter of IEEE AP/MTT/EMC/COMM in Tucson AZ. He is a general co-chair of the 8th International Workshop on Antenna Technology. He also serves as an associate editor for IEEE Antennas and Wireless Propagation Letters. hxin@ece.arizona.edu 520-626-6941.