Graphene-based Terahertz Antennas and Related Devices

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(joint work with Dr. M. Tamagnone, Harvard University, USA, and Dr. S. Capdevila, EPFL Switzerland)

Abstract

In recent years there has been a noticeable increase in the interest of the research community in THz technologies and science. This growing interest in the THz gap is somehow driven by the potential applications in a wide range of fields such as security, counterfeit detection, imaging, spectroscopy, etc. However, there is still the need of devices, technologies, or materials that provide the same flexibility that we have nowadays at lower (microwave) frequencies. Such flexibility would enable, for instance, to realize essential components like switches and isolators, to electronically beam-steer or modulate the THz radiation, or even to reconfigure the behavior of our THz devices so that they can change their behavior according to specific needs. One of the materials that have shown an enormous potential to this end is graphene, the well-known bi-dimensional material, discovered in 2004. This fact has been acknowledged at the European level with the launching of the European Graphene Flagship project (http://graphene-flagship.eu/), one of whose aims is to explore all the electromagnetic and photonic possibilities opened by the control of this new material. This presentation will overview the recent activities in our laboratory related to the potential uses of graphene for reconfigurable telecommunication and remote sensing devices in the THz frequency range. This includes not only graphene controlled radiating elements and reflectarrays, but also the use of graphene in related components, such as switches, isolators and modulators. This research is framed by the development of theoretical concepts and upper bounds allowing design & optimization of graphene devices and by the set-up of measurement systems able to characterize the electromagnetic wave properties of graphene and related materials. In addition, some innovative alternatives for developing reconfigurable and beam-steering antennas in the THz range, like the use of elastomer materials will be described in detail and experimental results for THz reflectarrays will be presented.
Biography

Juan R. Mosig was born in Cadiz, Spain. He received the Electrical Engineer degree from the Universidad Politecnica de Madrid, Madrid, Spain, in 1973 and the Ph.D. degree from the Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland, in 1983.

Since 1991, he has been a Professor in the Laboratory of Electromagnetics and Acoustics (LEMA) at EPFL and its Director since 1999. He has been a member of the Swiss Federal Commission for Space Applications, the Chairman of the EPFL Space Center, the Director of the Electrical Engineering Section at EPFL, and a Vice-Dean of the Humanities and Social Sciences College at EPFL.

His research interests include electromagnetic theory, numerical methods, planar antennas, terahertz applications, and novel technologies. In these areas, he has authored four chapters in books and more than 700 technical publications, including more than 200 papers in peer-reviewed top international journals.

Dr. Mosig has held scientific appointments with several universities in France, Denmark and USA. He is a IEEE Fellow and the recipient of the 2015 IEEE APS Schelkunoff Award for the best Transactions AP paper of the year and of the James R. James Lifetime Award Achievement (2015). He has been the Swiss Delegate for European COST Antenna Actions since the 1980s and the Chair of two completed Actions 284 and IC0603 ASSIST (2003–2011). He is a founding member and former Chair of the European Association on Antennas and Propagation (EurAAP) and was Conference Chair in two editions of the EurAAP Conference EuCAP (Nice, France, 2006 and Davos, Switzerland, 2016).
Electromagnetics for the next generation of over-the-horizon radars

Prof. Stuart J. Anderson (Space and Atmospheric Physics Group, University of Adelaide, Australia)

Abstract

We are presently witnessing a resurgence in the development and deployment of radars operating in the HF band and exploiting propagation modes that support over-the-horizon (OTH) surveillance and remote sensing. Radars of this type emerged in the 1950’s and 60’s to address strategic and intelligence missions, evolved in the 1970’s and 80’s to provide air and surface surveillance, as well as remote sensing of ocean surface conditions, then, with a few exceptions, entered a period of what might be termed ‘benign neglect’ as the superpowers greatly scaled down their OTH radar programs at the end of the Cold War. But now a new era of proliferation is underway, and the challenge for radar designers is to take advantage of recent advances in electromagnetics to improve and extend radar performance. Areas of particular interest include novel radiating structures, high fidelity representations of the geophysical environment and its dynamics, associated propagation models, electromagnetic scattering from targets made of complex materials, exploitation of MIMO architectures, and all these in the framework of wide-band, nonlinear, non-stationary, phenomenology. And not to forget, the adversarial context. This talk will offer a personal assessment of the tasks, the prospects and the challenges ahead.

Biography

Stuart J. Anderson received the B.Sc. and Ph.D. degrees in physics from the University of Western Australia, Perth, Australia, in 1968 and 1972, respectively. In 1974, he was invited to join the team being assembled in the Australian Defence Science and Technology Organization to develop the Jindalee over-the-horizon radar system, where he assumed responsibility for ocean surveillance and remote sensing, leading to the world’s first fully operational OTHR wide area ocean surveillance system. He has worked as a Visiting Scientist in a number of countries, particularly the U.S., U.K., and France, as a consultant to their national HF radar programs.

Dr Anderson holds or has held Adjunct and Visiting Professor appointments at numerous universities in Australia and overseas, including University College London, Université Paris VI, and Université Rennes I, which, in 2005, awarded him an honorary doctorate for his contributions to radar science. In 2014 he retired from DSTO and took up a position of Adjunct...
Professor of Physics at the University of Adelaide. His research interests span ionospheric physics, radiowave propagation, radio oceanography, electromagnetic scattering, inverse problems, signal processing, passive coherent location, and microwave polarimetry. He has published over 320 journal papers, conference papers, book chapters, and reports in these fields. Dr Anderson was the recipient of the 1992 Australian Minister of Defence Science Award for Research Achievement for his pioneering contributions to over-the-horizon radar in both skywave and surface wave forms. He is the principal author of the chapter on OTH radar in the authoritative Radar Handbook.