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Guest Editorial

Vacuum Electronic Devices and Applications

Manpuran Mahto* and P.K. Jain

Department of Electronics & Communication Engineering, National Institutes of Technology, Patna - 800 005, India
**E-mail: mmahto@nitp.ac.in*

This issue of Defence Science Journal contains a collection of nine manuscripts from National Symposium on Vacuum Electronic Devices and Applications (VEDA-2019).

Vacuum Electronic Devices and Applications Society organises VEDA symposium/conference/workshop every year at different locations of India. VEDA has established itself as a leading platform for active and innovative research of microwave tubes. It provides a forum for knowledge sharing and exhibition of theoretical and technological development in the general areas of vacuum electronics devices and its system applications. It organises special session to enhance Research Institutes – Industries and Academia Interaction.

The 2019 edition of VEDA was held during November 21st-23rd, 2019 at National Institute of Technology (NIT) Patna, India, organised by Department of Electronics & Communication Engineering, NIT Patna in association with the VEDA Society of India. The main theme focused on the general areas of vacuum electronic device, technologies & applications, RF systems, high power RF, microwave & millimeter waves, vacuum microelectronics/Nano-electronics devices, metamaterials / metasurfaces inspired and other emerging RF devices, measurement & diagnostic tools, as well as related areas.

During three days of the VEDA-2019 symposium, six sessions were organised for presenting contributory research papers. In those sessions, fifty-one (51) papers were presented which were selected based on the peer reviews process. Based on the presentation and quality of work fifteen (15) papers are selected for next level process. Authors of these selected papers were asked to submit the full length paper incorporating the remarks given by the reviewers comment of VEDA-2019 review process and comments given during their presentation in VEDA-2019.

Out of fifteen manuscripts, we received the extended version of fourteen manuscripts. These manuscripts are sent again for peer review process with two or three reviewers. After receiving the review reports, authors have been asked to modify their manuscript according to reviewer's comments. We have again sent the modified papers to reviewers and after receiving from the acceptance from the reviewers, we have recommended fourteen papers in the special issue of VEDA-2019 Defence Science Journal. After getting the DSJ Editorial Observations, we have asked the authors to modify and submit the modified manuscript as per Defence Science Journal Editorial Observations. We have recommended fourteen papers in the special issue of VEDA-2019 Defence Science Journal of which nine papers are finally selected for this special issue. The details of the manuscripts are as follows:

1. Analysis, Design, and Simulation of an Axially-partitioned Dielectric-loaded Bi-frequency MILO

In this manuscript, a bi-frequency magnetically insulated line oscillator (MILO) was proposed and designed. The beam wave interaction behaviour and device RF output performance were investigated through 3D PIC simulation for typical diode voltage of 550 kV, and current 48 kA, respectively. The results illustrate that the proposed MILO generates RF peak power of ~3.5 GW at frequencies 3.62 GHz and 3.72 GHz. The conversion efficiency of the device was ~13.25%.

2. Design and Development of High Power Broad Band Dry RF Load

The authors have designed and developed a high power S-Band ferrite-based RF load which is capable of handling 3 kW average power at operating frequency 2998±20 MHz. The load exhibits excellent matching for a bandwidth of 105 MHz for Model-A and 151 MHz for Model-B at center frequency 2998 MHz. They obtained a return loss of 30 dB for a bandwidth of 250 MHz.

3. Design and Simulation of Extended Interaction Cavities for a Ka-band Multi-Beam Klystron

The authors have reported a design approach of ladder-type intermediate and input/output cavities for an extended interaction multi-beam klystron operating at 28.46 GHz. The cavity design parameters have been estimated using analytical formulae, and the same has been simulated using a commercial electromagnetic simulation tool. The operating mode of the cavity at 28.46 GHz has been identified from the electromagnetic field pattern, and corresponding cavity parameters like quality factor (Q), shunt impedance, and R/Q value have been estimated through simulation.

4. Design of Double Barrier Ceramic Radio Frequency Vacuum Window

The authors have described the RF design of a double barrier ceramic coaxial vacuum window. Alumina 99.5% pure is considered as ceramic barrier material while inner and outer conductors are oxygen free copper. Parametric sweep provided optimised width and diameter of the step for improved return loss and insertion loss response. Sweep no. 3 having length (L), width (W) and diameter (D) values 90 mm, 30 mm and 36 mm respectively provided the best return loss and insertion loss response i.e. -67 dB and -0.001 dB at 65 MHz. The field distribution inside the window was simulated at operating power level of 200 kW for both sweep 3 and 9 parameters. The maximum field strength and volume loss in ceramic were about 0.31kV/mm and 1.14 W respectively corresponding to sweep 3 parameters and were best optimised results. The field distribution for realistic model of window was carried out which provided maximum field strength of 0.42kV/mm and volume loss of 1.53 W.

5. Design of Magnetic Focusing System for a Compact Ka-band Helix TWT

In this paper, the design of magnetic focusing system (MFS) for a compact helix TWT operating in Ka-band has been studied. Issues related to the design of the magnetic focusing system have been discussed along with practical measurement results. The key design parameters considered for this TWT are: the cathode voltage is around 9.3 kV, beam current is 200 mA and total length of the tube not more than 6 inch with minimal weight.

6. Effect of Beam-tunnels on Resonant Frequency of Cylindrical Reentrant Cavity

The authors have demonstrated an improved analytical formulation for the calculation of cavity gap-capacitance of reentrant cavities having single and multiple beam-tunnels and its effects on the resonant frequencies.

7. Multipaction Susceptibility Margins in Space Travelling-wave Tubes

In this manuscript, the authors have studied the effect of multipaction breakdown margins in the output connector of a travelling-wave tube (TWT) and the margins are calculated for two practical output couplers operating in X-band and Ku-band frequencies with peak output power of 350W. The designs are found to have minimum power margin of around 14 dB and 17 dB for output couplers of the X-band TWT and the Ku-band TWT, respectively.

8. Output System of a 42/84 GHz, 0.5 MW, Dual Regime Gyrotron

The authors have studied the design of the output system for a dual regime Gyrotron in the context of India's requirement of clean energy. This design study consists of a dimpled wall quasi-optical launcher (QOL) and RF window. After proper coupling of energy from beam to RF wave, the amplified wave need to be down-convert in a Gaussian-like beam (much simplified lower order). The launcher is designed with a commercial software LOT/Surf3d. This Gaussian-like mode coming out from the gyrotron vacuum system through the RF window is coupled to the corrugated waveguide using Matching Optic Unit (MOU) section. The complete design of the RF window is carried out using Gyrotron Design Suite Version 4.0 (GDSv4.0 2016).

9. Simulation Investigations of High Power Overmoded Relativistic Backward Wave Oscillator with Trapezoidal Resonant Reflector

In this paper an S-band high power relativistic backward wave oscillator using a trapezoidal resonant reflector and overmoded slow-wave structure has been demonstrated. The trapezoidal resonant reflector and slow-wave structure are chosen to improve the RBWO power handing capability to gigawatt (GW). The Trapezoidal resonant reflector enhances the pre-modulation during electron beam propagation, thus increasing the generated RF signal overall efficiency and coherency. The particle-in-cell simulation generated an RF output power ~5.4 GW in TM01 mode at ~3.6 GHz in a 2.0 T magnetic field and developed a 13.5 kA current for a 1.2 MV DC cathode voltage. The power conversion efficiency is achieved as ~33 %.

From these nine (extended) papers, we observe that VEDA community is actively engaged in vacuum electronics devices and its system applications. We hope that the readers will enjoy this special issue of VEDA-2019.