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SIMPLE INEXPENSIVE PLASMA GENERATION SET UP USING HIGH VOLTAGE TELEVISION PLATE

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Abstract: Inexpensive old color television high voltage plate was used to fabricate an air plasma generation set up. High voltage up to 18000V was applied between two needles for observing air breakdown. Breakdown current was measured for various distances between the two electrodes. Also the cross section area of receiving electrode was varied by using two steel rods having different diameters and also by means of different positioning to receive the breakdown current.

Keywords: Electric Spark Gap, Air Breakdown, Plasma Generation

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INTRODUCTION

Plasma was first discovered by Sir William crook in 1879 [1]. The name plasma was coined by Irving Langmuir in 1928 [2]. Although it is the most abundant visible matter in the universe, it is rare on earth, since a very high temperature is required to generate plasma. Nowadays generation of plasma in laboratory is a routine work and it is even found in some of the technologically advanced consumer items like plasma TV's. There are number of methods which can be employed to generate plasma in laboratory. By applying a sufficiently high voltage across the electrodes pointing towards each other in air can create air plasma. Number of circuits has been designed to generate spark gap. S Hussain et al. demonstrated low cost, easily maintained, and reliable field distortion spark gaps which operate at a voltage up to 30 kV [3]. Low current spark gap was demonstrated and characterized for determining electron density profile using interferometer [4]. Thomas Baby et al. developed low inductance, triggered spark gap switch suitable for a high-current fast discharge system [5]. By employing high intensity laser, plasma can be generated in laboratory [6, 7]. Plasma can be characterized to know its temperature [8], electron density [8], optical properties [9] etc. Plasma research is yielding not only a greater understanding of the universe but it

is used in many practical applications such as manufacturing techniques [10], consumer products [11], the prospect of abundant energy [12], more efficient lighting [13], surface cleaning [14], etc. In recent times, biomedical applications of plasma have also grown. Nowadays, plasma sources are employed for bacterial inactivation [15] and tissue sterilization, decontamination of medical instruments [16-18], surface modification of implantable biomaterials [19-20]. In this paper, we have shown that how an inexpensive old color television high voltage plate can be used to fabricate an air plasma generation set up. High voltage up to 18000V was applied between two needles for observing air breakdown. Breakdown current was measured for various distances between the two electrodes. Also the cross section area of receiving electrode was varied by using two steel rods having different diameters and also by means of different positioning to receive the breakdown current.

EXPERIMENT SET UPS:-

Experimental set up of for electric spark gap is as shown in Fig. 1. It comprises of a high dc voltage television plate (18 KV) and a spark gap made up of two pointed sewing needle separated by a particular distance.

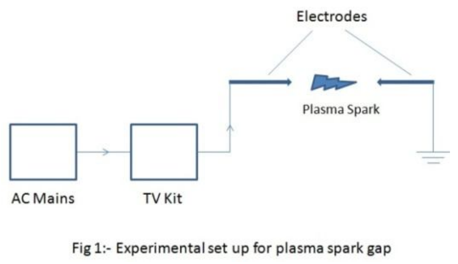

Fig. 1: Experimental set for electric spark gap generation.

Electric arc was produced by applying high voltage (18 KV) across the needle (0.6 mm diameter) shaped electrodes shown in Fig. 1. Breakdown current was measured using an ammeter between receiving electrode and ground as shown in Fig.2.

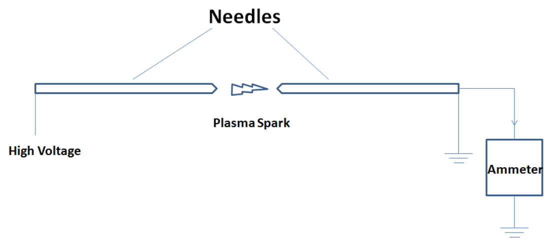

Fig.2: Breakdown current measurement between two pointed needles.

To see the effect of diameter on the breakdown current, bigger diameter steel rod (9.5 mm) was used in place of receiving needle electrode as shown in Fig. 3.

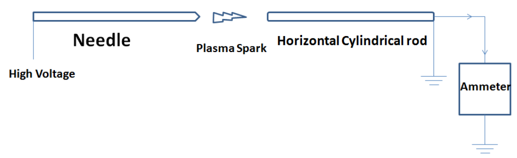

Fig. 3: Breakdown current measurement between one pointed needles and steel rod having diameter of 9.5 mm.

Fig.4 shows third configuration used for comparing the effect of positioning of receiving electrode. Here instead of keeping the electrode horizontal it was kept vertical.

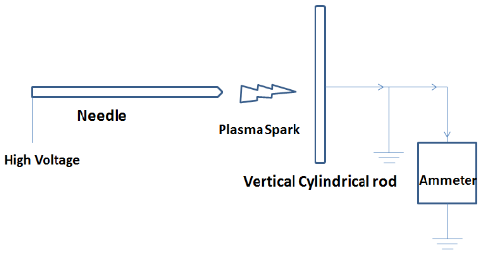

Fig.4: Breakdown current measurement between one pointed needles and vertically kept steel rod having diameter of 9.5 mm.

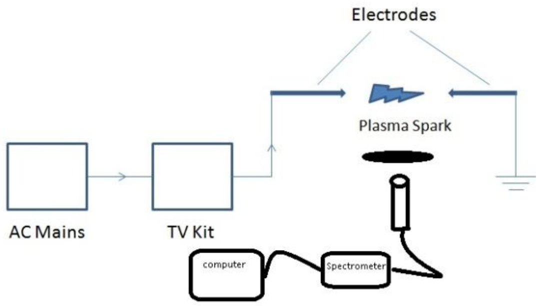

Fig.5: Experimental set up for recording the optical spectrum of electric spark.

Fig.5 shows the experimental set up for recording the plasma radiation occurring because of air breakdown. Fibre optic spectrometer (ocean optics) was used to capture the radiation and it was connected to computer for viewing and storing.

RESULTS AND DISCUSSIONS:-

Distance between the electrodes verses breakdown current is plotted for the three cases as shown in Fig. 2, 3 and 4. Fig. 6 shows the variation of breakdown current with respect to distance between two needle electrodes as shown in Fig. 2, 3 and 4. As the distance between electrodes varied from 4.2 cm to 3 cm breakdown current increases as expected for set up shown in fig. 2. At distance 2.8 cm, suddenly the sparking between the electrodes gets converted into electric arc flame, hence the current gets reduced to 10 mA from 0.2 A. For the set up shown in Fig. 3, pointed needle is replaced by steel rod having diameter 4.5 mm. Current seen to be slightly increased as compared to previous case because of the larger effective cross sectional area of receiving electrode. Current decreases continuously as the distance between the electrode decreases.

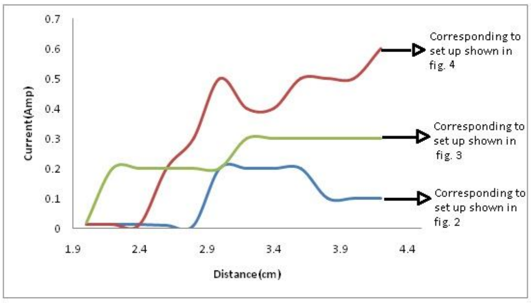

Fig. 6: Distance between electrodes Verses Breakdown current for the set ups shown in fig. 2, 3 and 4.

At distance 2 cm, the sparking between the electrodes gets converted into electric arc flame, hence the current gets reduced to 18 mA from 0.2 A. In the previous case, this distance was 2.8 cm here it is 2 cm. When the steel rod was kept vertical to receive spark slightly different variation but the trend of decrease in the current with decrease in the distance was same as in the previous two cases. In this case, receiver electrode effective cross sectional area is larger than previous two cases and hence the largest current received in this case is also largest. Abrupt increase in the current occurs momentarily at a distance 3 cm. At 2.4 cm the sparking between the electrodes gets converted into electric arc flame, hence the current gets reduced to 12 mA from 0.2 A. Fig. 7 shows the spectrum obtained because of air breakdown. It shows the continuum as expected. Radiation from 300 nm to 1000 nm is seen in the spectrum. Intensity of radiation in between 600 nm to 700 nm is highest and symmetric around this highest point.

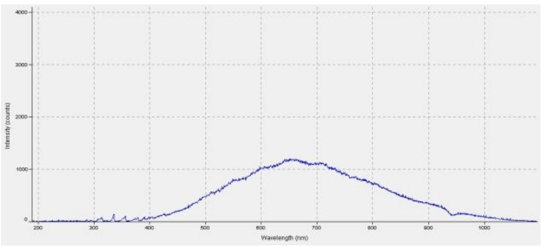

Fig. 6: Continuum spectrum obtained because of air breakdown

CONCLUSION:-

Simple inexpensive electric spark gap was fabricated using television high svoltage plate. Air breakdown was seen to start at a distance of 4.2 cm between the two needle electrodes.

Breakdown current was observed to be dependent on distance between the electrode and also the effective cross sectional area of receiving electrode.

REFERENCES:-

1. Francis Chen, Introduction to plasma physics: Plenum press; (1997).

2. Sen S.N. Plasma Physics (Plasma State of Matter), Pragati Prakashan (2004)

3. S Hussain and M Zakaullah. "Reliable Field Distortion Spark Gap for Plasma Focus," 2007 *Plasma Sci. Technol.* 9 504 doi:10.1088/1009-0630/9/4/27. Received 7 July 2006.

4. Patra, A. S.; Phukan, T.D.; Khare, A., "Measurement of two-dimensional electron density profile in a low current spark using interferometry," Plasma Science, IEEE Transactions on , vol.33, no.5, pp.1725,1728, Oct. 2005.

5. Thomas Babyt, T Ramachandran, P Radhakrishnan, V P N Nampoori and C P G Vallabhan, "A low-inductance, long-life, triggered spark gap switch for Blumlein-driven lasers," Meas. Sci. Technol. 2 (1991) 873-875.

6. J P Singh and S N Thakur, Laser induced Breakdown Spectroscopy, Elsevier science (2007).

7. Noll Reinhard, Laser induced Breakdown Spectroscopy: Fundamental and Applications, Springer Publications (2012).

8. V K Unnikrishnan, K Alti, V B Kartha, C Santhosh, G P Gupta and B M Suri, "Measurements of plasma temperature and electron density in laser-induced copper plasma by time-resolved spectroscopy of neutral atom and ion emissions", Pramana: Journal of Physics, Vol. 74 (6), 983 (2010).

9. V. K. Unnikrishnan, K. Mridul, Rajesh Nayak, Kamlesh Alti, V. B. Kartha, C. Santhosh, and B. M. Suri, "Trace Element Analysis Using Laser Induced Breakdown Spectroscopy (LIBS) Technique", AIP Conf. Proc., Vol. 1349, pp. 475 (2011).

10. Pulsed Laser Deposition of Thin Films, edited by Douglas B. Chrisey and Graham K. Hubler, John Wiley & Sons, 1994.

11. J P Boeuf, Plasma display panels: physics, recent developments and key issues 2003 J. Phys. D: Appl. Phys. 36 R53

12. Jeffrey P. Freidberg, Plasma Physics and Fusion Energy, Cambridge University Press (2008).

13. Amarendra Swarup, “Physicists create great balls of fire,” NewScientist.com June 2006.

14. M. E.V.Shun’ko and V.S.Belkin "Cleaning Properties of atomic oxygen excited to metastable state $2s^2 2p^4 (^1S_0)$", J. Appl. Phys 102, 083304 (2007)

15. G. Fridman, G. Fridman, M. Peddinghaus, M. Balasubramanian, H. Ayan, A. Fridman, A. Gutsol and A. Brooks. “Blood coagulation and living tissue sterilization by floating electrode dielectric barier discharge in air,” plasma chem..plasma process., 26:425-442, 2006.

16. K. Stapelmann, O. Kylian, B. Denis, and F.Rossi. “On the application of inductively coupled plasma discharges sustained in ar/o2/n2 ternary mixture for sterilization and decontamination of medical instruments”. J. Phys. D:Appl.Phys., 41:1920051, 2008.

17. F. Rossi., O. Kylian, H. Rauscher, D. Gilliland, and L. Sirghi. “Use of a low pressure plasma discharge for the decontamination and sterilization of medical devices,” Pure and Applied Chemistry, 80:1939-1951, 2008.

18. N. Hayashi, N. Tsutsui ,S. Tomari, and T. Weimin Guan. “Sterilization of medical equipment using oxygen radicals produced by water vapour rf plasma.” IEEE Transactions on plasma science, 36:1302-1303, 2008.

19. P.K. Chu. “Plasma surface treatment of artificial orthopaedic and cardiovascular biomaterials” .Surface and Coating technology.201:5601-5606, 2007.

20. E. Piskin. “plasma processing of biomaterials .”Journal of Biomaterials Science,4:45-60,1993.