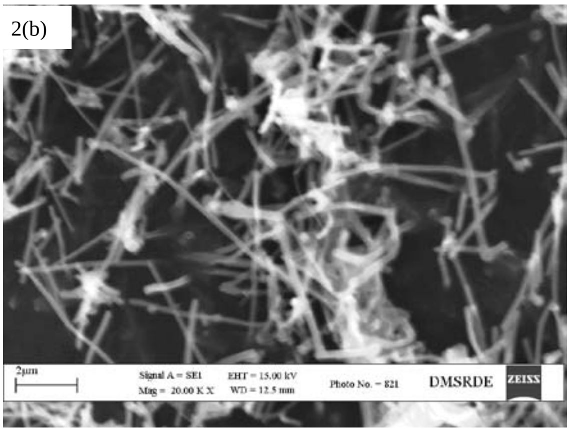

Figure 2: SEM micrographs of (a) Carbon Black Powder (CBP), (b) MWCNTs Powder

Figure 3 shows the SEM image of prepared nano-composite showing localised MWCNT dispersed in CBP/PU matrix.

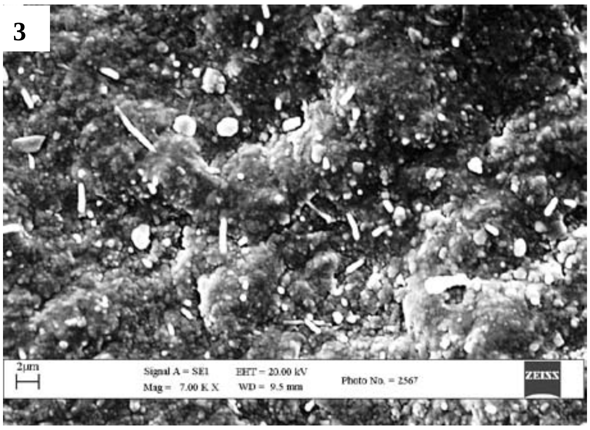

Figure 3: SEM micrographs of nanocomposite of MWCNT dispersed in CBP /PU Matrix

3.2 Thermal Properties

Thermo gravimetric analysis (TGA) has been carried out to study the thermal stability of the prepared nano-composite sample.

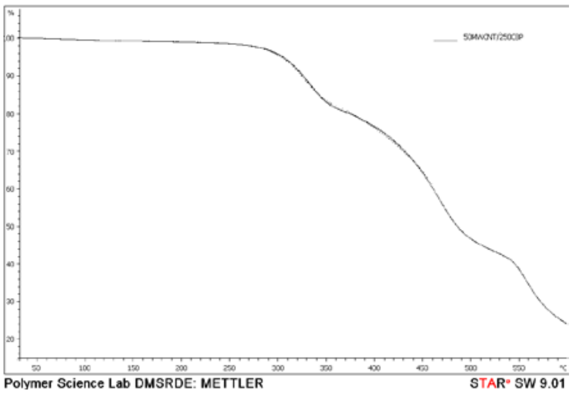

Figure 4: TGA of MWCNTs dispersed in CBP/PU

Figure 4 shows the TGA plot of prepared nano-composite which exhibits weight loss in several steps. But the prepared nano-composite is found to have a thermal stability at least up to 290 ^{0}C.

3.3. Permittivity Spectra

Figure 5 (a) and (b) shows the variations of the dielectric ε_r (ε' and ε'') and magnetic parameters μ_r ($\mu' \approx 1$ and $\mu'' \approx 0$) respectively of nano-composite material in the frequency range of 2–18 GHz. Conducting MWCNT and Carbon black powder mixed in PU (insulating) matrix leads to variation of the dielectric and magnetic parameters with frequency producing large accumulation of charges due to the dynamic nature of the incident electromagnetic wave.

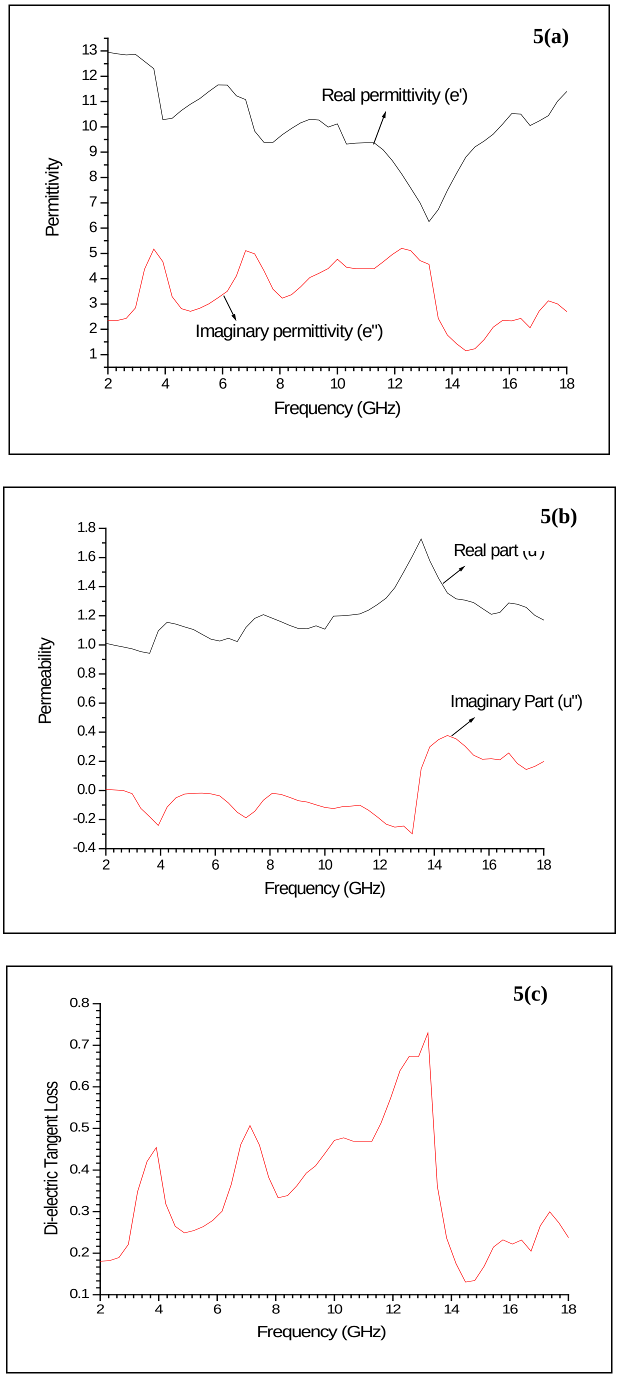

Figure 5: (a) Electric permittivity, (b) Magnetic permeability and (c) Di-electric Tangent loss (tan δ_e) vs. frequency variations of nano-composite

This leads to formation of small localized conducting areas in the nano-composite leading to the observed pattern of the electromagnetic parameters. MWCNTs encapsulated in the CBP are considered to play an important role in improving the electric loss of composite. The electromagnetic parameter and tangent loss results in the variation of Z_{in} and thus affects the absorbing properties.

3.4. Microwave Absorbing Properties

The reflectivity of the prepared nano-composite sample having 250mg carbon black and 50 mg MWCNT in one ml polyurethane for various sample thickness has been calculated using experimentally obtained values of ε_r and μ_r. Figure 6 depicts the variation of the reflectivity with frequency regime of 2- 18 GHz.

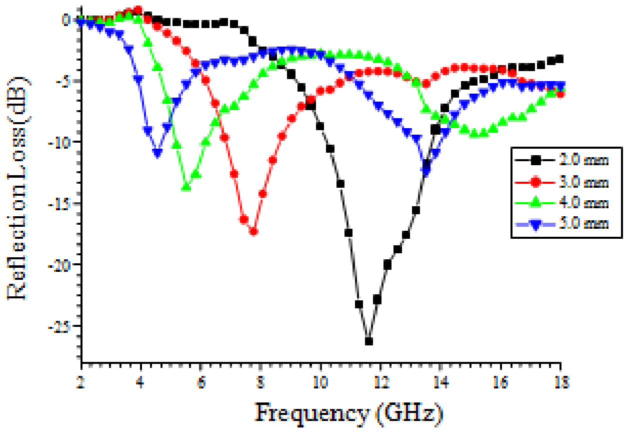

Figure 6: Frequency dependency vs. Reflection loss of composite for different thicknesses

The maximum absorbing peak is found to be -26.23 dB at 11.6 GHz which is in the range of X wave band and the corresponding value of matching thickness (d_m) is 2.0 mm. The bandwidth of the reflection loss (R_f) below −10 dB is 3.22 GHz (13.52 GHz-10.30 GHz).

4. Conclusion

We have successfully prepared the Carbon black and MWCNT PU based torroidal shaped nano-composite. Sample having 250mg carbon black and 50 mg MWCNT in one ml polyurethane with 2 mm thickness has shown more than 10 dB reflection loss in the frequency band of 10.30 GHz to 13.52 GHz with peak absorption of -26.23 dB at matching frequency of 11.6 GHz. Samples of relatively less thickness have shown relatively larger reflection loss towards higher end of frequencies. Thus the prepared carbon black and MWCNT based composite may be utilized in stealth technology as well as EMI shielding for particular band of microwave frequencies.

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Author's Profile

K.C. Tripathi received the M.Sc. degree in Physics (specialization in electronics) from CSJM University, Kanpur. U.P. (India) in 1997 and M. Tech. degree in Computer Science and Engineering from Allahabad

Agricultural Institute, Deemed University, Allahabad in 2007. From July 2008, he has joined Ph.D. (Applied Physics) program from Defence Institute of Advance Technology, Pune. Presently, he is working in DMSRDE, Kanpur, DRDO, Ministry of Defence, Govt of India.

Dr. S.M. Abbas is presently Scientist 'F', Joint Director and head of Central Analytical Facilities in Defence Materials and Stores Research and Development Establishment (DMSRDE), Kanpur, India. He did his M. Tech. in Metallurgical Engg. and Materials Science from IIT Bombay in 1997 and Ph.D. in Physics (Solid state materials) from IIT Delhi in 2007. His area of interest is characterization of materials, development of camouflage materials/ products, Radar and multispectral Camouflage Net, Mobile Camouflage System, and Radar absorbing Materials Composites. He has published 07 papers in reputed journals and presented 10 papers in International conferences. He received two best paper awards: one in International conference on Advanced Materials (ICAM 2007) at IISc., Bangalore, and another in MRSI conference 1997 at BARC Mumbai,. He has also received DRDO cash 1999 for development of thermal Pads.

Dr. R.B. Sharma obtained M.Sc. (Physics) from Agra University (1979), M.Phil (Physics) from Rajasthan University (1986) and PhD from Pune University (1997). He has taught Physics courses at undergraduate/ Post graduate/ doctoral level for more than 30 years. He has supervised 3 Ph.D. and 8 M.Tech/ MS theses. Presently, he is working as Scientist 'G' at DRDO headquarters, New Delhi and also as an adjunct faculty at the Department of Applied Physics, DIAT Pune, India. He has published more than 30 research papers in International journals

Dr. P.S. Alegaonkar received the M.Sc. degree in Physics (specialization in nuclear techniques) from University of Pune, Pune, Maharashtra (India) in 1999 and Ph.D. degree in Physics from same department in 2004. From Mar 2010, he has joined Defence Institute of Advance Technology, Pune. Presently, he is working in as Assistant Professor in Applied Physics Department.