CHAPTER 7

CONCLUSIONS AND FUTURE SCOPE OF THE WORK
Carbon or graphite respectively is well known as one of the most outstanding high temperature materials because of its extreme refractoriness combined with favourable thermophysical properties. The suitability of these materials can be illustrated by their most important technological applications, such as
- Carbon bricks for blast furnaces
- Nuclear applications of graphite such as coating of fuel particles and as construction material in high temperature reactors.
- Anodes for electrolysis of molten salts
- Thermal electrodes in industrial furnaces for reduction and melting.
- Nozzles, nose tips and other parts in missile technology
- Further applications in high temperature technology such as electrical heating elements, spark electrodes, crucibles etc.

As far as high temperature thermal stresses and shock behaviour are concerned, most severe working conditions are found for graphite in missile technology. The most dangerous limitation in applications of carbon and graphite is the oxidation at high temperature. For low temperature applications carbon and graphite have been extensively used for ages and these were obtained from calcined filler coke and binder such as coal tar or petroleum pitch as raw materials.

The carbonization and graphitization of raw materials resulted in the production of carbon formed an industrial process. The conventional process as it is known as, the resulting carbon products obtained have porosity and large voids which further reduce the strength and ability to withstand stress. Therefore, in order to densify these carbon or graphite materials, modified techniques such as cyclic heat treatment and impregnation at high temperatures and high pressures (200 kg/cm²) (HIP) are used. These processes are quite expensive and take long time for densification. Also the complicated shapes and big size articles can not be made by these methods.

Keeping in view the above limitations, a new process of making self sinterable carbon from polyaromatic mesophase was developed. In this technique the coal tar pitch are carbonized in the furnace in inert atmosphere. During heating process, spherical anisotropic liquid crystal formed, grew and coalesce to form large domains. Thus solid with a mosaic anisotropic pattern is formed. The microstructure of the solid can be controlled by selecting the parent material and by controlling the
of the solid carbon samples made with coke grounded for 150 hrs. is 9-11%, weight loss is also 10-12%. Thus with increasing the compacting pressure and heating rate, shrinkage increases. On increasing pressure or heating rate, the solid carbon sample shows cracks, because of the high shrinkage in the former case and high rate of evolution of volatiles in the latter case. The three parameters i.e. grinding time, compacting pressure and heating rate thus optimized for further studies. With these optimized parameters solid carbon samples were prepared. These samples were heat treated to 1000-2700°C. The ultimate density of solid carbon samples reached 1.84-1.86g/cc. The properties of these solid carbon samples were measured. XRD studies showed that the solid carbon samples are highly graphitic. Electrical resistivity of these samples showed that the value of resistivity decreases with increasing density. Also with high temperature heat treatment the microstructure of the sample gets transformed to isotropic carbon from anisotropic. Compressive strength of solid carbon samples sintered at 1000°C was found maximum (650-675 kg/cm²) and it decreased with high temperature treatment to 2700°C. This may attributed to transformation in structure from polyaromatic to graphitic.

The sinterable carbon on heating in air at 1000°C, burn off completely showing a weight loss of 100%. This conforming to the presence of pure carbon. To improve the antioxidation property ceramics were incorporated to the solid carbon samples. The details of technique for the fabrication is mentioned in chapter 2. Finally ground sinterable coke was mixed with carbides of silicon and boron. This mixture was further co-grounded and cold pressed to make a solid carbon sample which was called carbon/ceramic composites. The effect of co-grinding time, ceramic content and heating rate on the ultimate properties was studied and optimized. The green density as well as the density of the sintered composites increases with increasing co-grinding time. The density of composite increases with addition of silicon carbide upto 30%. In case of boron carbide increase in density was observed upto addition of 10%. While shrinkage and the weight loss showed a decrease with addition of any of ceramic additives. Due to the formation of thin layer of sinterable coke on the surface of ceramic particles, density was found to be higher in case of carbon/ceramic composites (Carbon+30%SiC+10%B₄C). Porosity of sintered carbon/ceramic composites was found to be higher compared to solid carbon samples. But with high temperature treatment porosity was found to reduce. This was also attributed to the change in structure from polyaromatic to graphitic.