ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Cannons of Dindigul Fort- A marvel of Indian metallurgical skill

Rajendran S[1*], Thilak Kumar S[2], Syed Abuthahir[1], Sobiga C[1], Valentine Nancy P[1], Sivasankari M[1], Sumitha R[1], Syed Zahirullah S[3]

[1]Department of Chemistry, RVS School of Engineering and Technology, Dindigul-624 005, India.
[2]PPC & Logistics Department, RNS-11, SIPCOT Industrial Growth Centre, Oragadam, Kanchipuram,India.
[3]Department of Physics, MIET Engineering College, Tiruchirapalli, India.
***Corresponding author: E-Mail: susairajendran@gmail.com**

ABSTRACT

Dindigul Fort is located about 400 km from Chennai, Tamilnadu, India. There are number of brick structures on the top, possibly built during the British period. There is a circular freestanding bastion on the top at a strategic location on which several cannons were mounted. Artillery and cannons were introduced during the 17th century. The cannons are still free from corrosion. Analysis of a sample of iron rust scratched, from the cannon found at Dindigul rock fort, by SEM, EDAX and FTIR spectra reveal that the sample consists of carbon, oxygen, silicon, phosphorus, sulphur, calcium and iron (55.5%). The particles are present in the nano state probably as spheres, plates, and clusters arranged in layers. The particle size is in the range of 46.89 nm. Hence the strength and corrosion resistance of the cannon is due to the presence of the composites in the nano scale. The FTIR Spectrum confirms the presence of γ FeOOH, α FeOOH and Fe_3O_4. Surprisingly the magnetic oxide of iron, Fe_3O_4, is present as nanoparticles. This layer is very close to the iron surface; next comes α FeOOH layer and then γ FeOOH layer present on the upper layer of the cannon.

KEY WORDS: Dindigul fort, cannon, corrosion resistance, oxides of iron, magnetic oxide of iron, SEM, EDAX, FTIR.

1. INTRODUCTION

The geographical coordinates of Dindigul Fort is latitude 10.35 & #176; N and longitude 77.95° E. The fort of Dindigul has height of nine hundred feet and is mostly created of granite. There is also a temple located in the vicinity of the fort. At present, it is held by the Archaeological Survey of India. Dindigul is a strategic place located overlooking the valley through which the forces from Karnataka country gained access into the Madurai in late medieval period. The style of carving recalls the influence of dying delicate artistic traditions on soapstone of Karnataka. One of the inscriptions on a shrine records a donation by the Vijayanagara king Krishnadevaraya to the Tambiranar (the presiding deity) of Dindigul. Dindigul Fort has a circumference of almost 2.75 km and a height of 900 feet. Artillery and cannons were introduced during the 17th century. Thus double walls were built in the fortress in order to resist heavy artillery. The cannons were established at various vantage points across the fort and storehouse for arms and ammunition were also built with different safety measures. Presently, Dindigul Fort is maintained by the Archaeological Survey of India and has been developed as a tourist destination.

A section of the cannons found at Dindigul fort is shown in Fig 1. It is interesting to note that the cannons are still free from corrosion. It will be very useful to know the composition of the materials which constitute the cannons of Dindigul fort.

Cannons in Dindigul Fort

Fig.1.Cannons in Dindigul Fort

The high status of iron and steel technology in ancient and medieval India is reflected in the manufacture and use of numerous large iron objects, including forge-welded cannons. Such cannon, found at Nurwar, Mushirabad, Dacca (in Bangladesh), Bishnupur, Bijapur, Gulbarga, and Thanjavur, exemplify the medieval Indian blacksmith's skill in the design, engineering, and construction of large forge-welded iron objects. The wrought-iron cannons found in different parts of India were manufactured from individual iron rings that were forge welded together. Medieval blacksmiths continued to use this technique in the fabrication of small and large iron objects, such as the Delhi and Dhar iron pillars. The cannon was fabricated by forge welding and not by casting. The chemical composition of the iron, used in the construction of the cannon, determined by a Jobin Yvon JY-38S inductively coupled plasma atomic emission spectrometer, is 93.4 wt.% Fe, 0.01 Cr, 0.003 Al, 0.026 Ni, 0.003 Mo, 0.042 P, and 0.411 C. The present work is undertaken to know the corrosion resistance and composition of cannons found at dindigul rock fort by FTIR, SEM and EDAX Spectroscopy.

2. EXPERIMENTAL

A sample of iron rust was scratched, with much difficulty, from the cannon found at Dindigul rock fort. This sample was used to record SEM, EDAX and FTIR spectra.

2.1. Surface analysis by FTIR spectroscopy: FTIR spectra were recorded in a Perkin Elmer Spectrophotmeter 1600 series. The film was carefully removed, mixed thoroughly with KBr and made into pellets and the FTIR spectra were recorded.

2.2. SEM and EDAX spectra: SEM and EDAX spectra were recorded in field Emission Scanning Electron Microscopy (FESEM-SUPRA 5S)-(ARLZEISS, GERMANY). SEM provides a pictorial representation in the surface to understand the nature of the surface film and particle size.

3. RESULTS AND DISCUSSION

3.1. Analysis of FTIR Spectrum: The FTIR Spectrum (KBr) of the sample (iron oxide) scratched from the cannon is shown in Fig 2. It is interesting to note that the peaks confirm the presence of FeOOH (436, 1022, 1463, 1630 cm^{-1}), α- FeOOH (412, 789, 907 cm^{-1}) and Fe_3O_4 (2921, 2851, 1629, 1376, 1221, 1022 cm^{-1}). Surprisingly the magnetic oxide of iron, Fe_3O_4, is present as nanoparticles. This layer is very close to the iron surface; next comes the α -FeOOH layer and then FeOOH layer present on the upper layer of the cannon. Similar observation is made in the case of Delhi iron pillar also. Presence of phosphorus (as per EDAX spectrum) also favours the formation of protective iron phosphate coating on the metal surface. Iron silicate also protects the metal from corrosion. Also presence of calcium silicate and calcium sulphate enhance the protection of metal. Similarly iron sulphate also plays an important role in protecting the metal surface of the cannon.

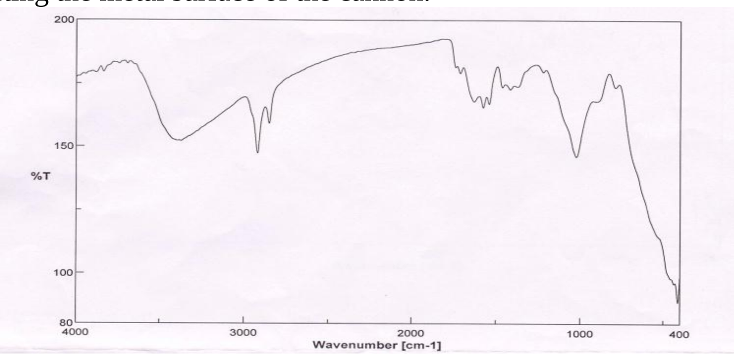

Fig.2.The FTIR Spectrum (KBr) of the sample (iron oxide) scratched from the cannon

3.2. Particle size determination from SEM analysis: The SEM images of the sample are shown in Figures 3 and 4. It is observed that the particles are present in the nano state probably as spheres, plates, and clusters arranged in layers. The particle size is in the range of 46.89 nm. Hence the strength and corrosion resistance of the cannon is due to the presence of the composites in the nano scale.

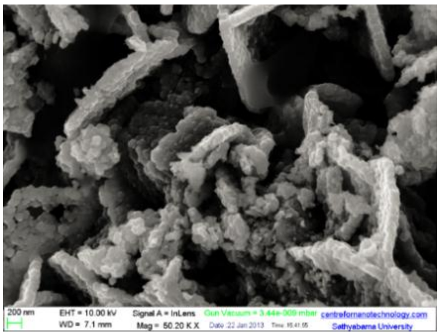

Fig.3.The SEM images of the sample

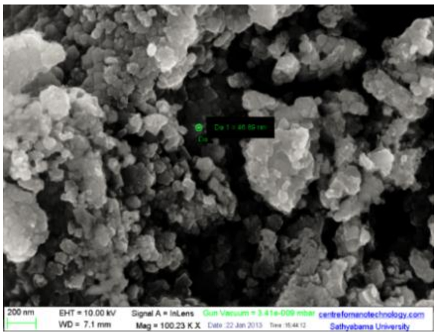

Fig.4.The SEM images of the sample (nano particle size)

3.3. Analysis of EDAX image: A portion of the cannon was scratched and that sample was used for recording EDAX. The EDAX image is shown in figure 5 and EDAX spectrum is shown in Figure 6.The results are given in Table 1.

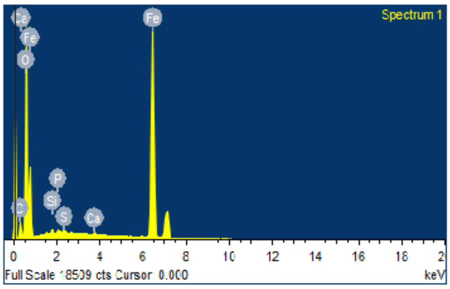

Fig.5 & 6.The EDAX image of sample collected from the cannon and the EDAX spectrum of sample collected from the cannon

Table.1.Weight % and atomic % of various elements present in the sample collected from the cannon

Element	Weight %	Atomic %
C K	7.64	16.28
O K	35.96	57.54
Si K	0.32	0.29
P K	0.26	0.22
S K	0.16	0.13
Ca K	0.16	0.10
Fe K	55.50	25.44
Total	100.00	100.00

It is seen from the Table 1 that the cannon is made of iron containing calcium, sulphur, phosphorus, silicon and carbon. The presence of oxygen indicates that the sample contains oxides of iron, calcium oxide, silicate, sulphate and phosphate. Close to the metal surface (iron) may be Fe_3O_4. Next layers may be silicates, sulphates, oxides and phosphates of calcium and iron. The contribution from iron being high since the sample contains 55.5 % of iron as seen from Table1.

4. CONCLUSION

The cannon found dindigul rock fort are found to be corrosion free even after many years. This is due to the fact that the iron oxides present in the cannon are in the nano particle range. This is confirmed by SEM and EDAX spectroscopy.

5. ACKNOWLEDGEMENT

The authors are thankful to the Archaeological Survey of India.

REFERENCES

Anantharaman T.R, The Rust less Wonder—A Study of the Iron Pillar at Delhi, Vigyan Prasar, 1996, 11–87.

Kannan R, and Balasubramanian R, Documentation on the Cannons in the Government Museum Chennai, 2000.

Richard A Nyquist, and Ronald O Kagel, IR Spectra of Inorganic Compounds, New York and London: Academic Press, 1971.

Ritter von Schwarz C, Uber die Eisen and Stahlindustrie Ostindiens (About the Iron and Steel Industry of East India), Stahl und Eisen, 21, 1901, 209–211, 277–283.

Roessler K, The Big Cannon Pipe at Tanjavur, Metal News, 19 (1), 1997, 1–4.