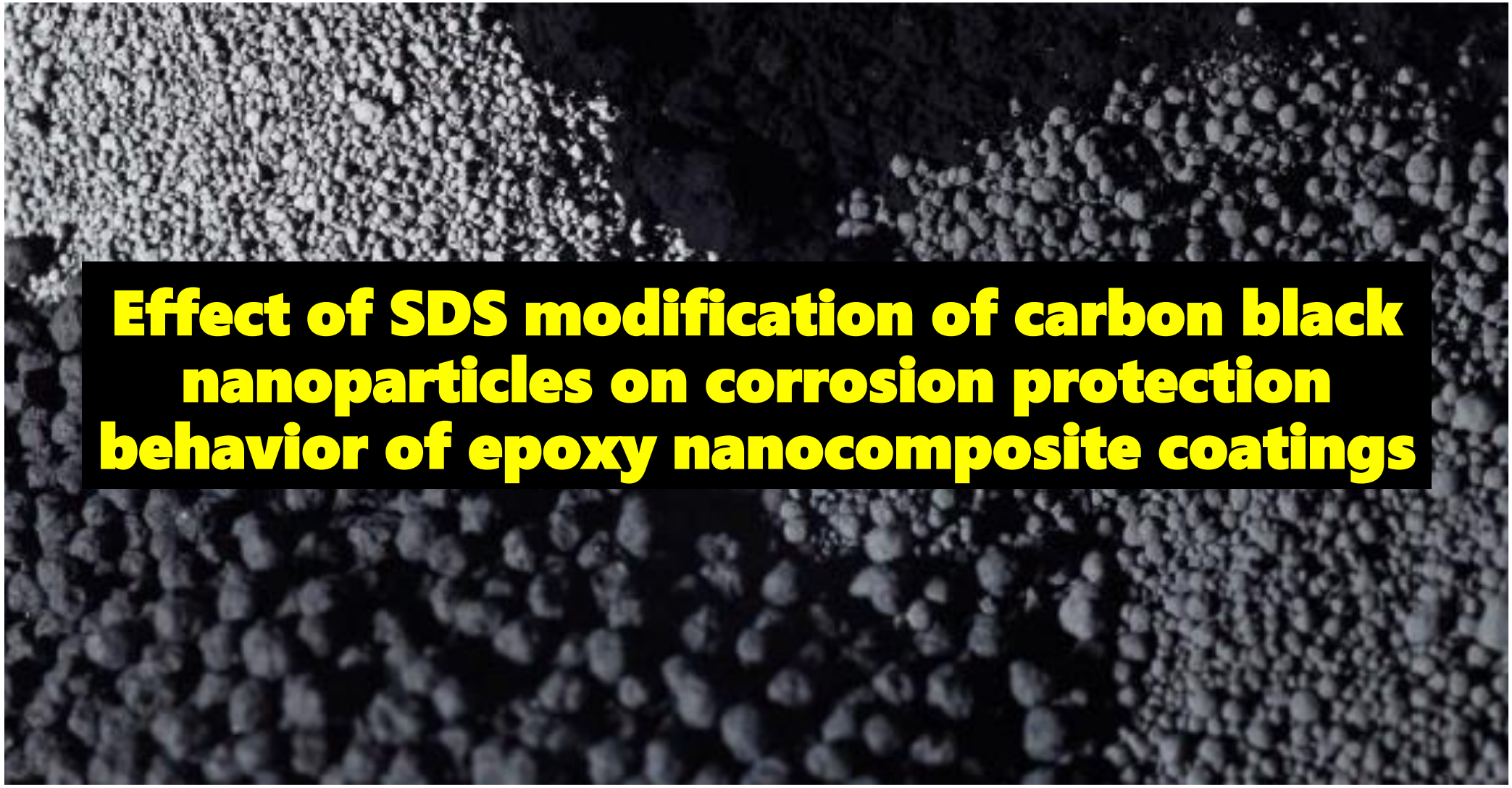


Effect of SDS modification of carbon black nanoparticles on corrosion protection behavior of epoxy nanocomposite coatings

Juliano Fernandes Teixeira

UFV
Universidade Federal de Viçosa

Article

Polym. Bull. (2015) 72:2297–2310
DOI 10.1007/s00289-015-1406-4

ORIGINAL PAPER

Effect of SDS modification of carbon black nanoparticles on corrosion protection behavior of epoxy nanocomposite coatings

Ahmad Ghasemi-Kahrizsangi[1] · Jaber Neshati[1] · Homeira Shariatpanahi[2] · Esmaeil Akbarinezhad[2]

Received: 28 December 2014 / Revised: 12 April 2015 / Accepted: 22 May 2015 /
Published online: 18 June 2015

Introduction

Epoxy-based coatings is used to protects surfaces from corrosion and decay.

Adding a few nanoparticles improve the protection of this product.

Why use CB nanoparticles?

CB can act as an ultraviolet stabilizer to prolong the lifetime of a coating.

Because a large specific surface area and high surface activity, the CB nanoparticles agglomerate easily.

Surfactants prevent agglomeration by adsorbing onto the suspended particles surface

Experimental techniques

Zeta potential — Colloid stability and surface morphology

Field Emission Gun Scanning Electron Microscopy (FEG-SEM) — Images of a surface sample

Dynamic light scattering (DLS) — size distribution of particles suspended in a liquid

Thermogravimetric Analyser (TGA) — Variation in the mass as a function of temperature

Electrochemical impedance spectroscopy (EIS) — characteristic of polymeric coatings in corrosive media

Materials

Non-modified CB nanoparticles

1 gr CB
100 ml epoxy solvent
sonicated for 2 h

Modified CB nanoparticles

2 gr of SDS
100 ml epoxy solvent
sonicated for 30 min

1 gr CB
sonicated for 2 h

FEG-SEM Zeta potential, DLS, TGA

Carbon Black N330 → Size of nanoparticle: 26 – 30 nm

Epoxy solvent
- 50 % xylene
- 15 % normal butanol
- 25 % methyl ethyl ketone
- 5 % ethylene glycol
- 5 % butyl glycol.

Preparation of nano-coating or +

weight ratio 10:4
- Neat epoxy resin grade Epon Shell 1001
- Polyamide hardener

stirred for 2 h at 2000 rpm.

The prepared coatings were applied on 10 cm 9 7 cm panels of mild steel.

FEG-SEM/EDS

To corrosion the samples

3.5 %wt NaCl solution

Effects of SDS on the dispersion of CB in the solvent

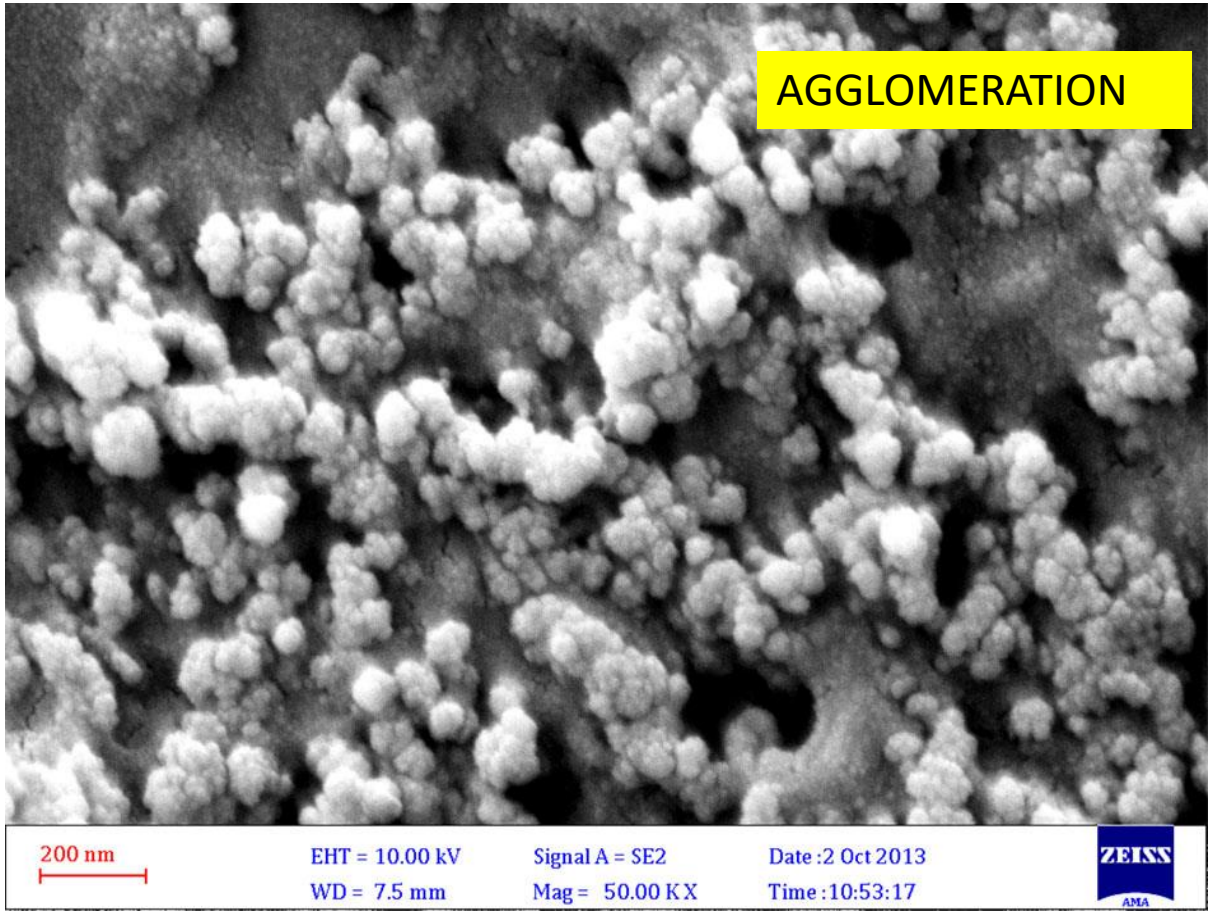


FIG 1: FEG-SEM micrograph of non-modified CB nanoparticles in the epoxy solvent

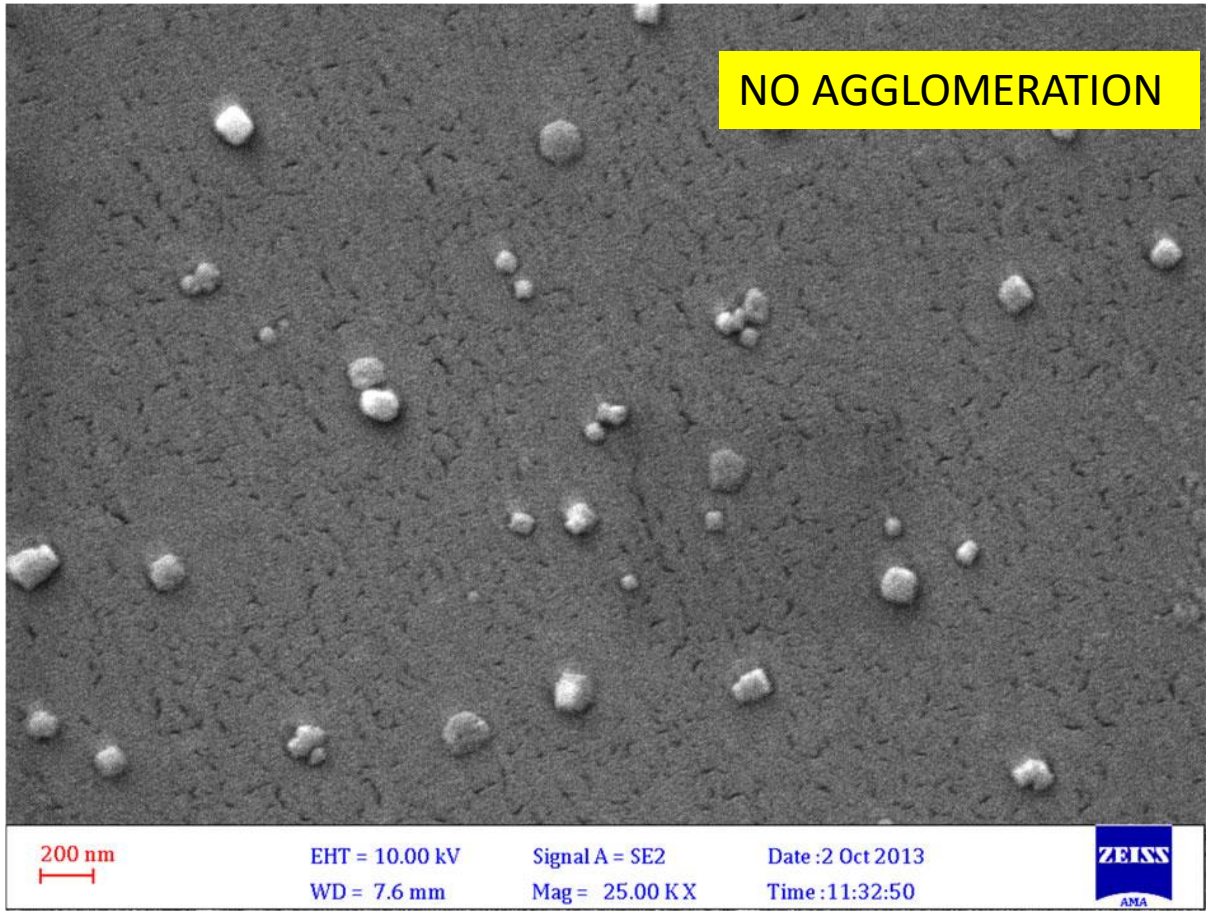


FIG 2: FEG-SEM micrograph of modified CB nanoparticles by SDS in the epoxy solvent

Effects of SDS on the dispersion of CB in the solvent

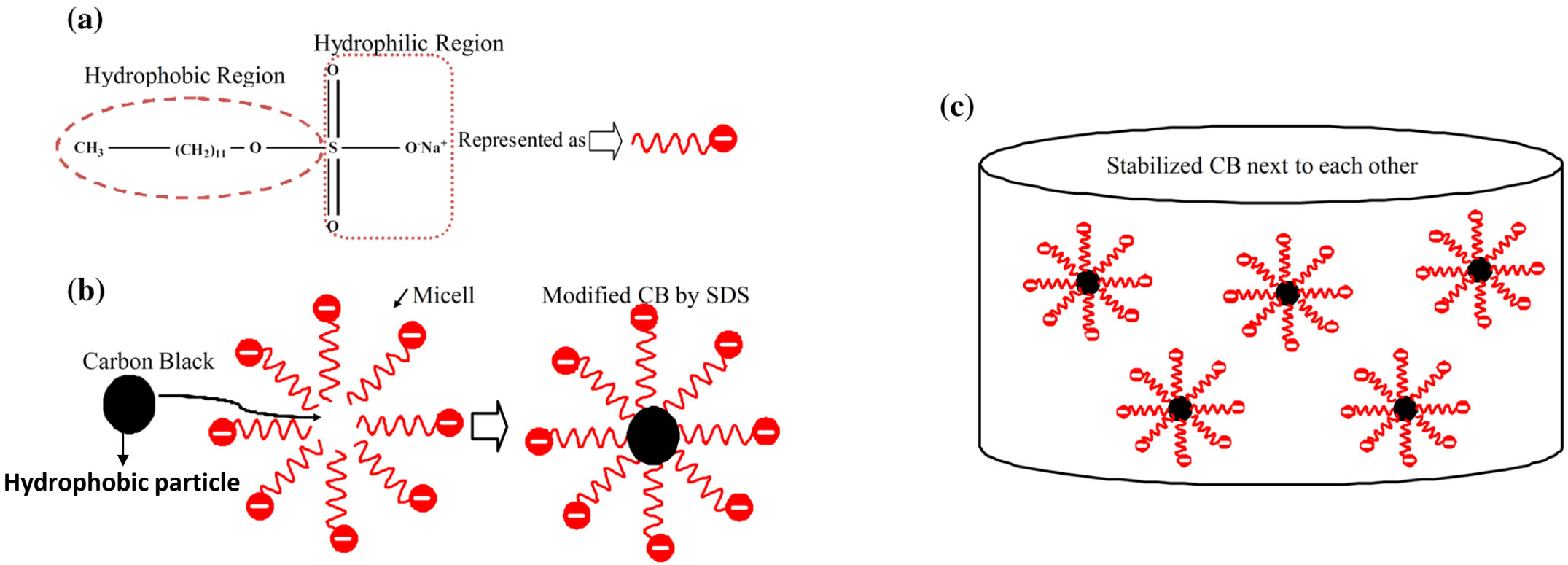


FIG 3: Proposed mechanism for dispersing CB nanoparticles by SDS surfactant in the epoxy solvent a scheme structure of SDS, b mechanism of absorbing CB by SDS and c dispersion of CB nanoparticlesin the solvent

It can be deduced that the thickness of the SDS surfactant is around the 2 nm.

Dynamic light scattering (DLS) and Zeta Potential

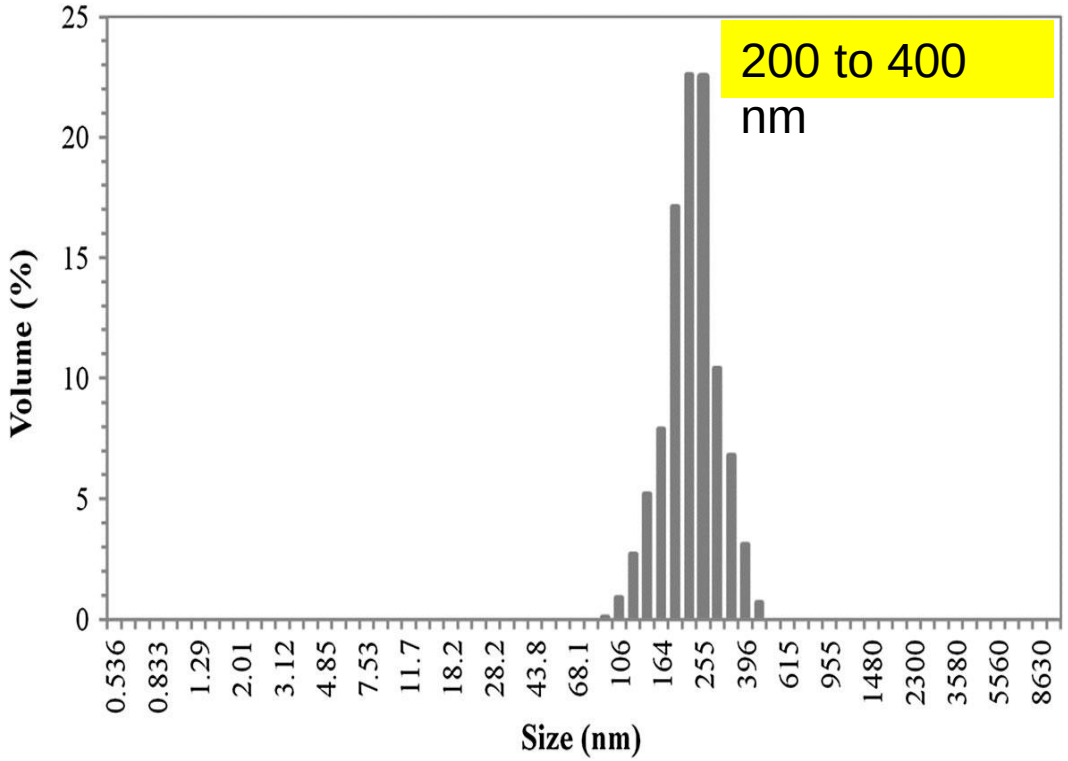


FIG 4: Size distribution of non-modified CB particles dispersed in the epoxy solvent

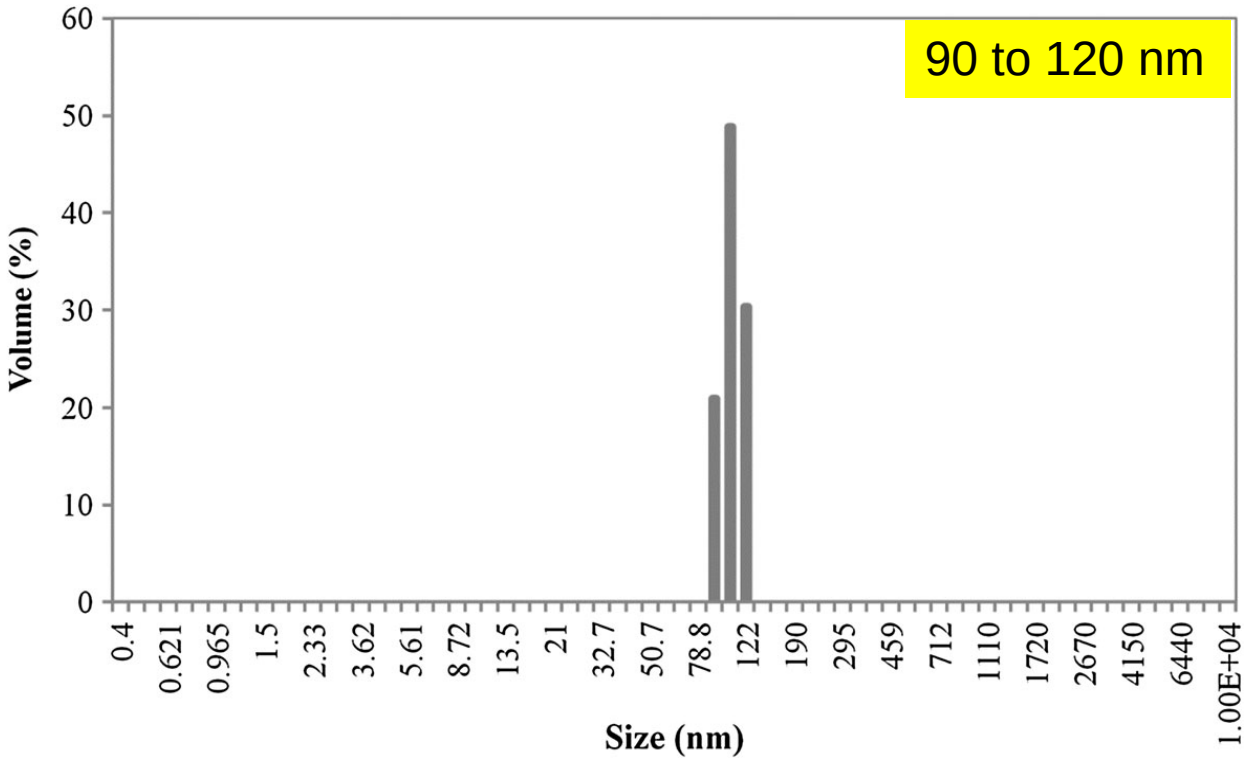


FIG 5: Size distribution of modified CB particles dispersed in the epoxy solvent

By adsorbing SDS on CB reduce attractive forces between CB nanoparticles

Dynamic light scattering (DLS) and Zeta Potential

High zeta potential confirm the stability.

When the potential is small, attractive forces may exceed than this repulsion and the dispersion may break and flocculate.

Table 1 Zeta potential of modified and non-modified of CB nanoparticles in the epoxy solvent

	Modified CB nanoparticles	Non-modified CB nanoparticles
Zeta potential (mV)	−22.7	−7.2

SDS increase the stability of CB in epoxy solvent.

Thermal properties of CB nanoparticles

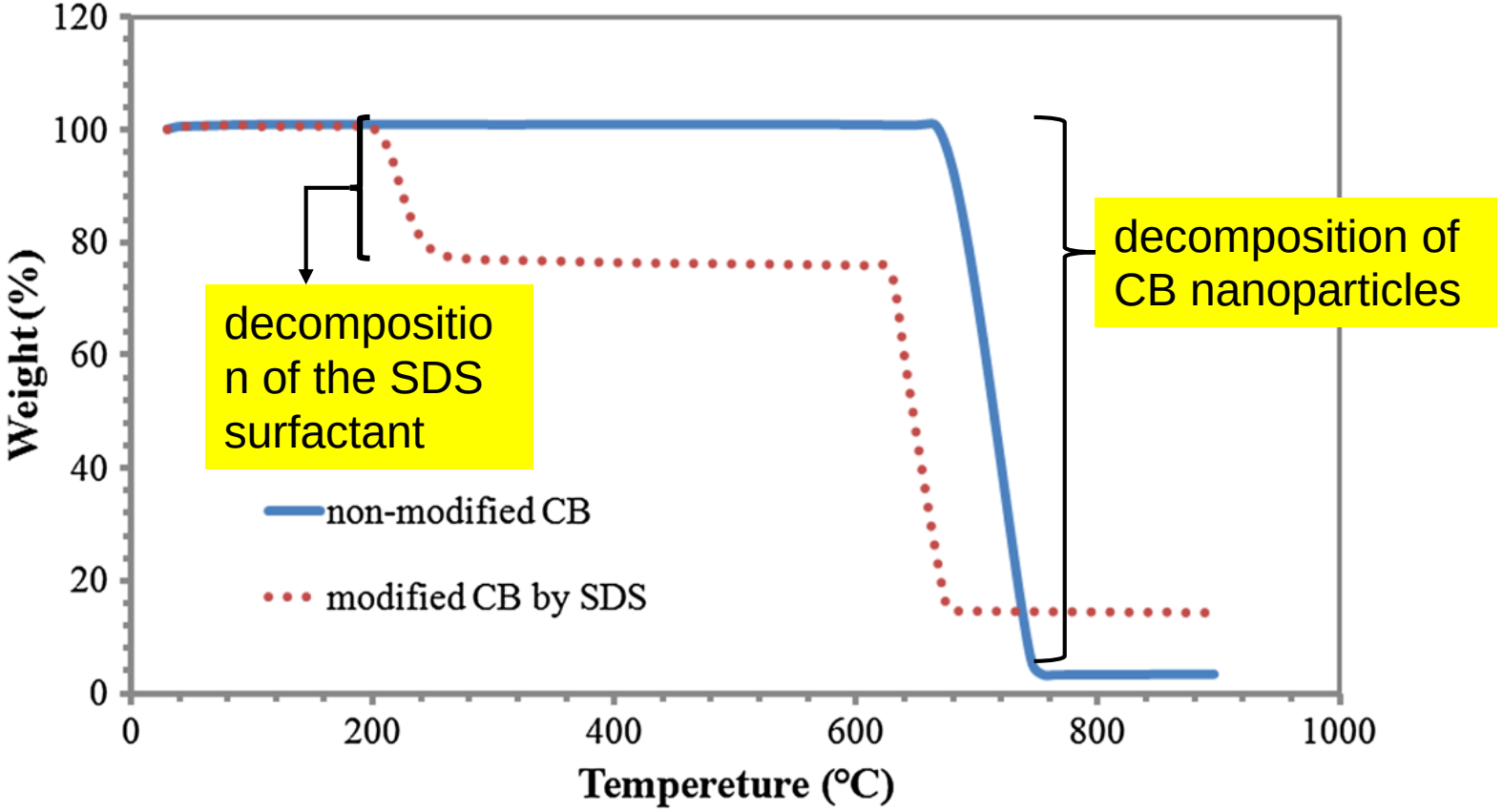


FIG 6: TGA profile non-modified CB (bold line) and modified CB by SDS (dotted line)

These results confirm that for modified CB nanoparticles, about 20 %wt SDS was successfully absorbed at the surface of CB nanoparticles

Effect of SDS on the morphology of CB/epoxy nanocomposite films

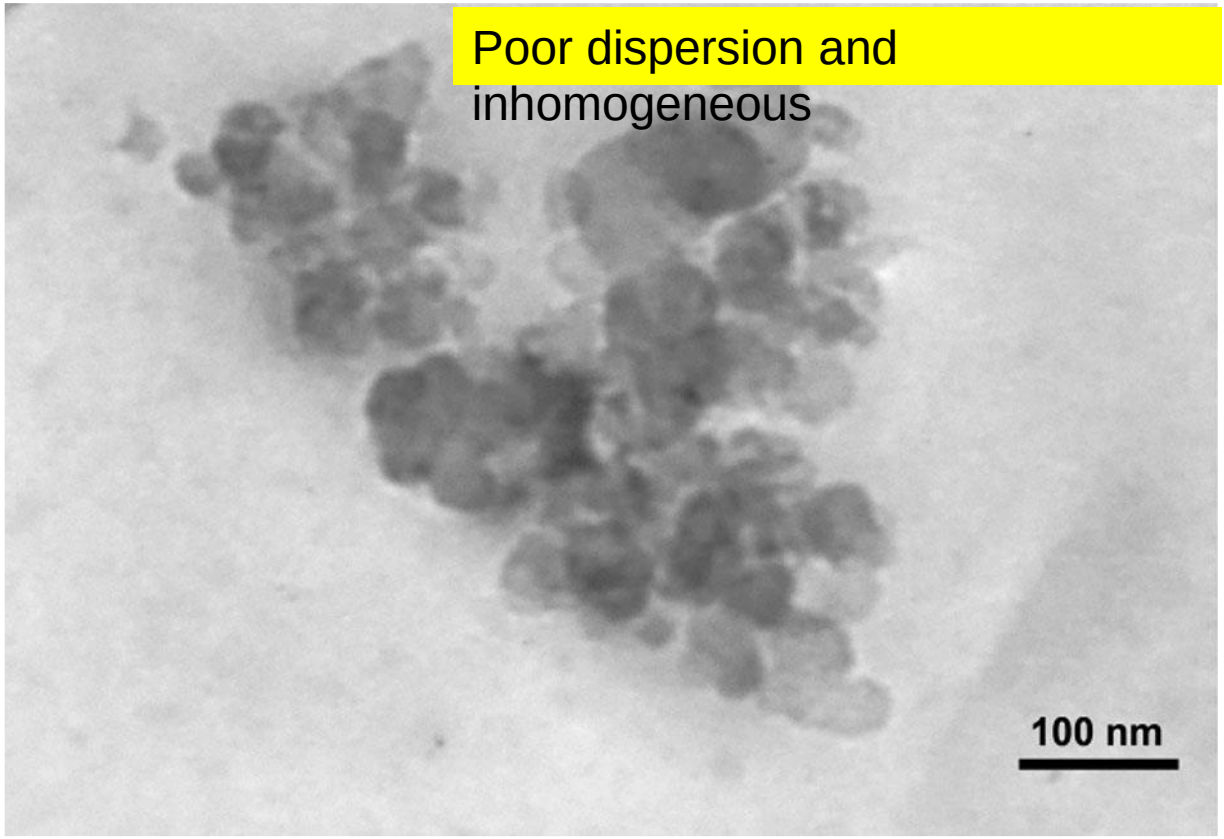


FIG 7: TEM micrograph of non-modified CB nanoparticles/epoxy coating without dispersion in the matrix

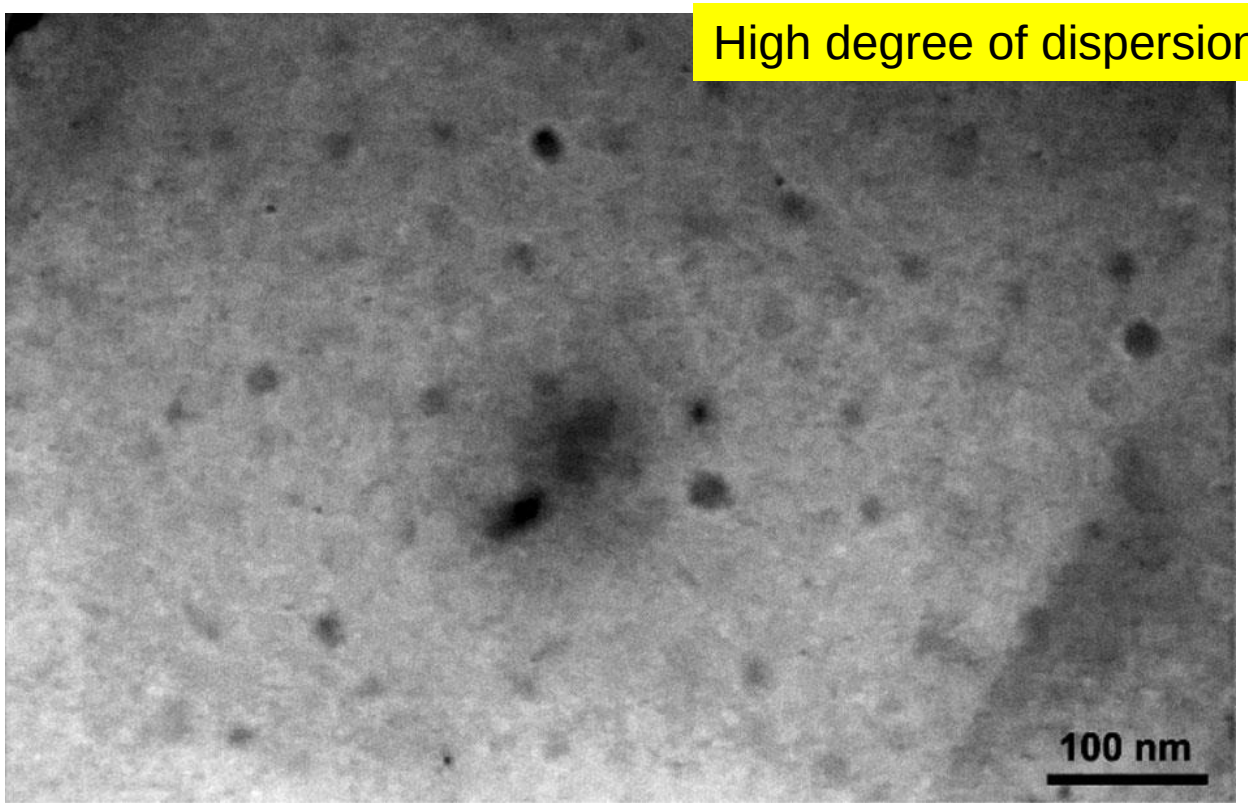
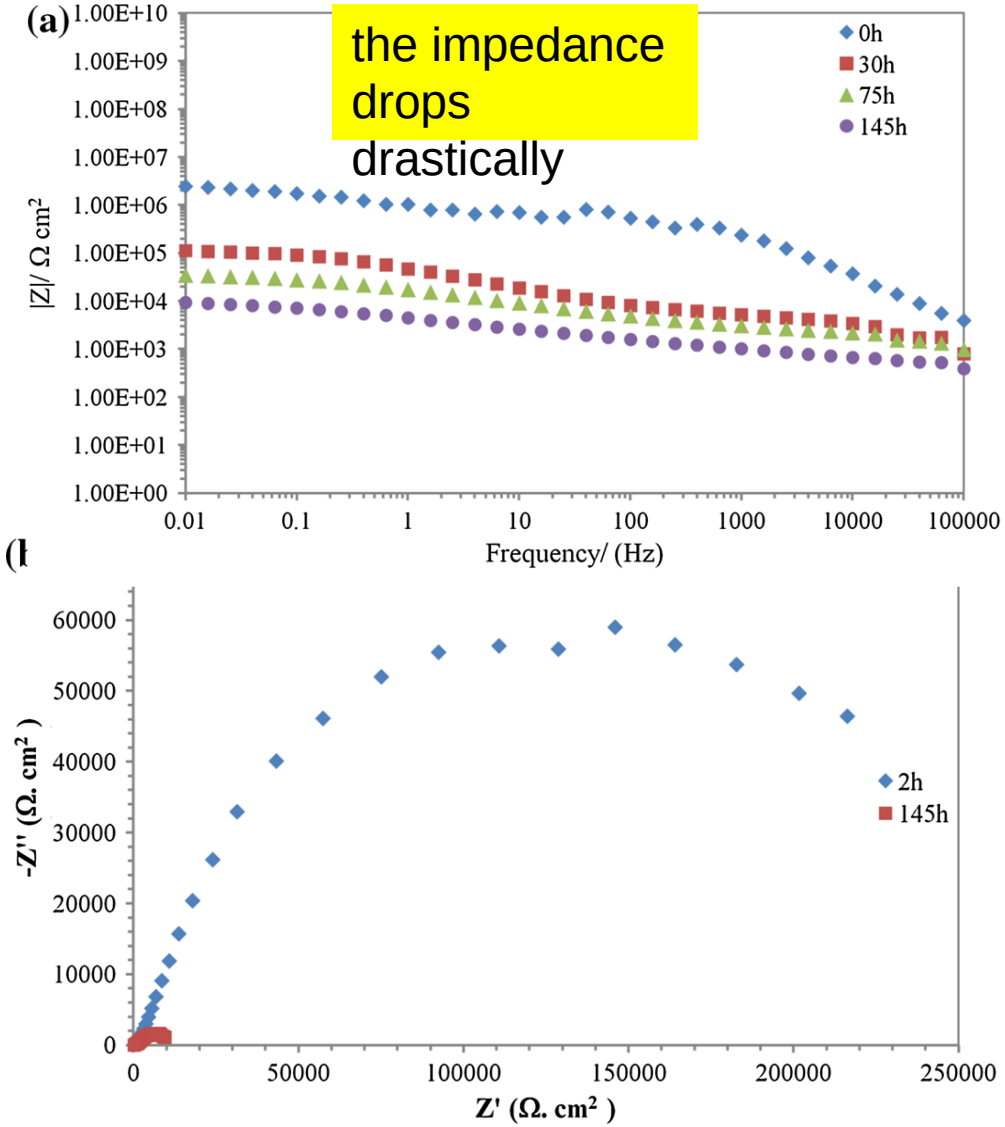


FIG 8: TEM micrograph of modified CB nanoparticles/epoxy coating with good dispersion in the matrix

Effect of SDS on anticorrosion behavior of CB/epoxy coatings



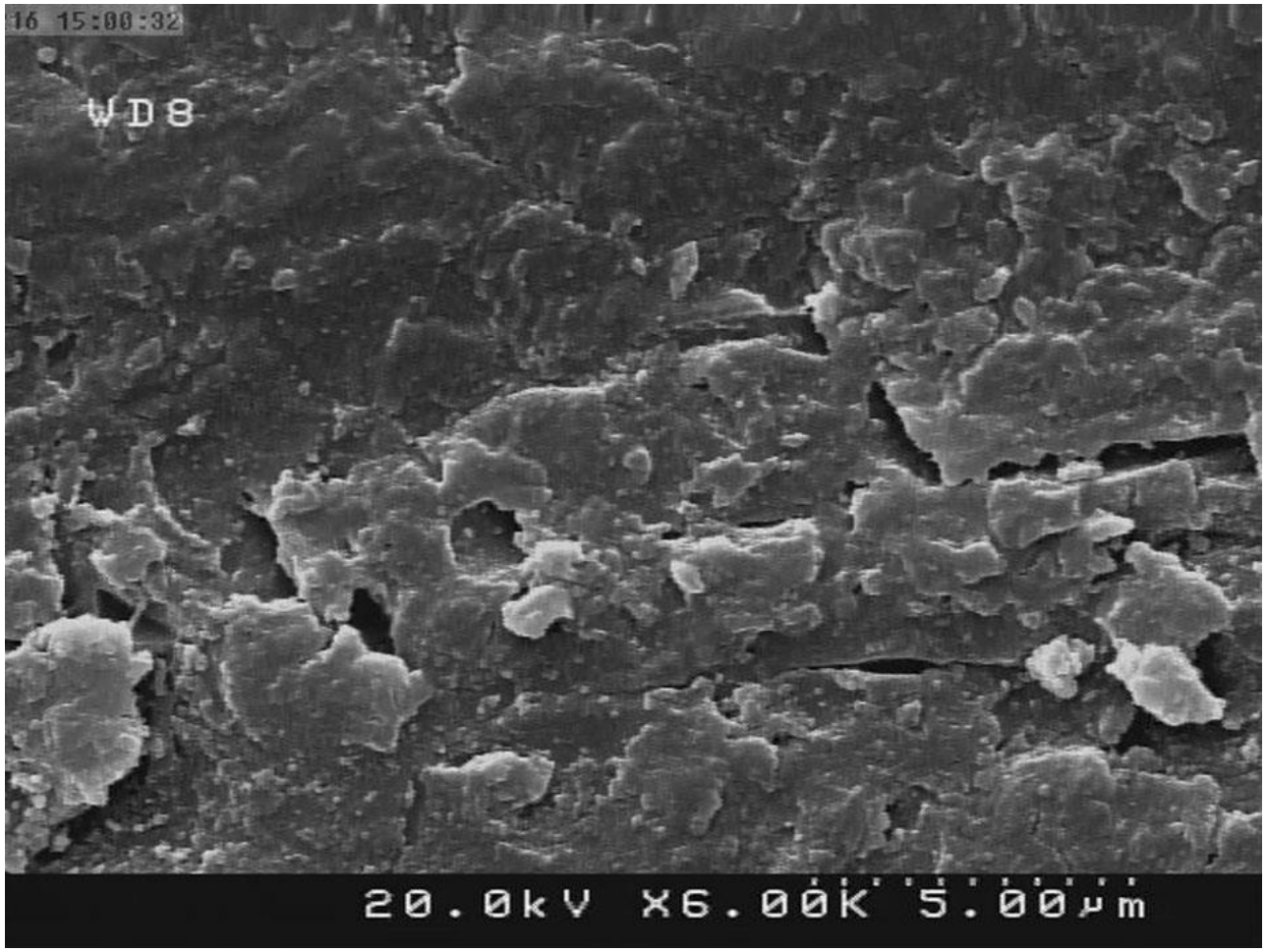


FIG 10: The cross section of coating without CB nanoparticles

FIG 9: a The Bode plots and **b** Nyquist plots of the EP coating at different immersion times in 3.5 % NaCl solution and 65 °C

Effect of SDS on anticorrosion behavior of CB/epoxy coatings

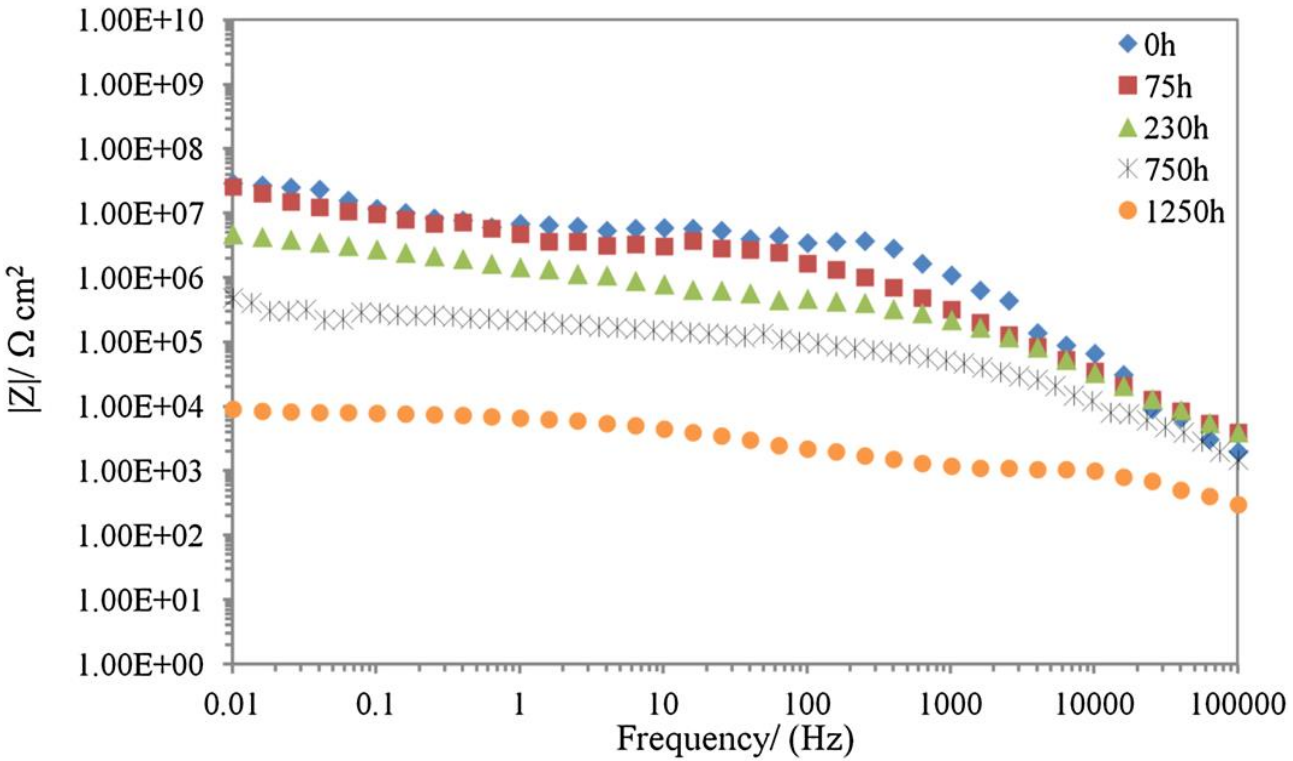


FIG 11: The Bode plots of coating with 0.75 %wt non-modified CB nanoparticles at different immersion times in 3.5 % NaCl solution and 65 C

Adding CB nanoparticles into epoxy resin, the corrosion resistance of coating increased.

CB nanoparticles can fill micropores and increase the density of coating which limits penetration of corrosive species into coating/metal interface

Effect of SDS on anticorrosion behavior of CB/epoxy coatings

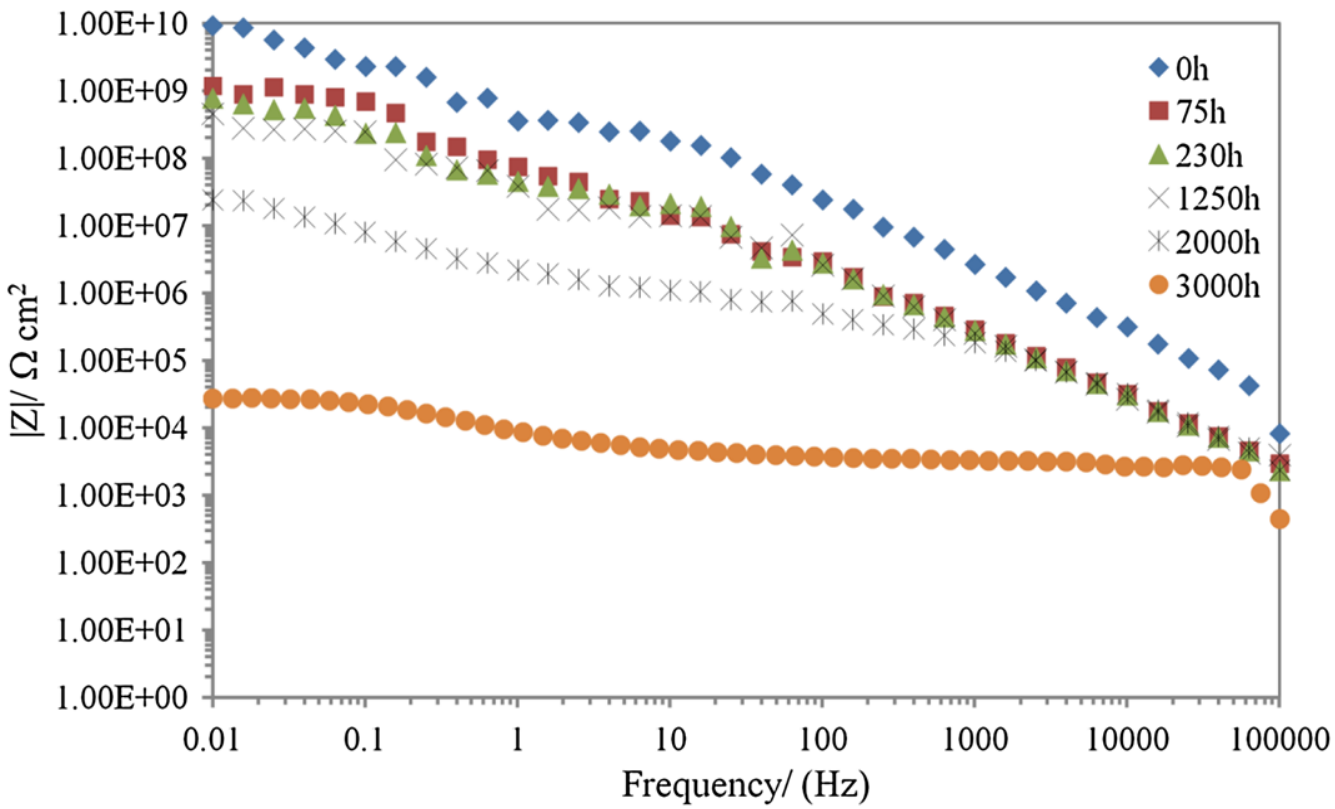


FIG 12: The Bode plots of coating with 0.75 %wt modified CB nanoparticles at different immersion times in 3.5 % NaCl solution and 65 C

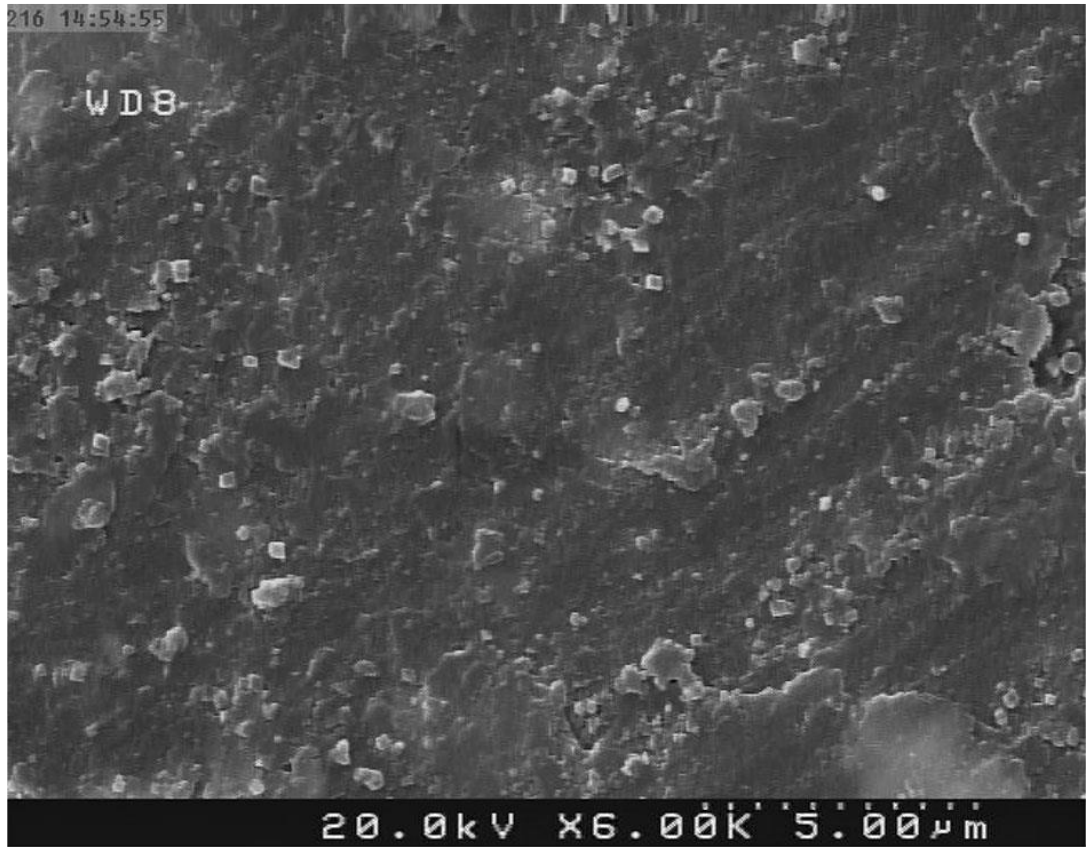


FIG 13: The cross section of coating with 0.75 %wt CB nanoparticles

High dispersion in modified CB nanoparticles led to fill more micropores in epoxy matrix

Effect of SDS on anticorrosion behavior of CB/epoxy coatings

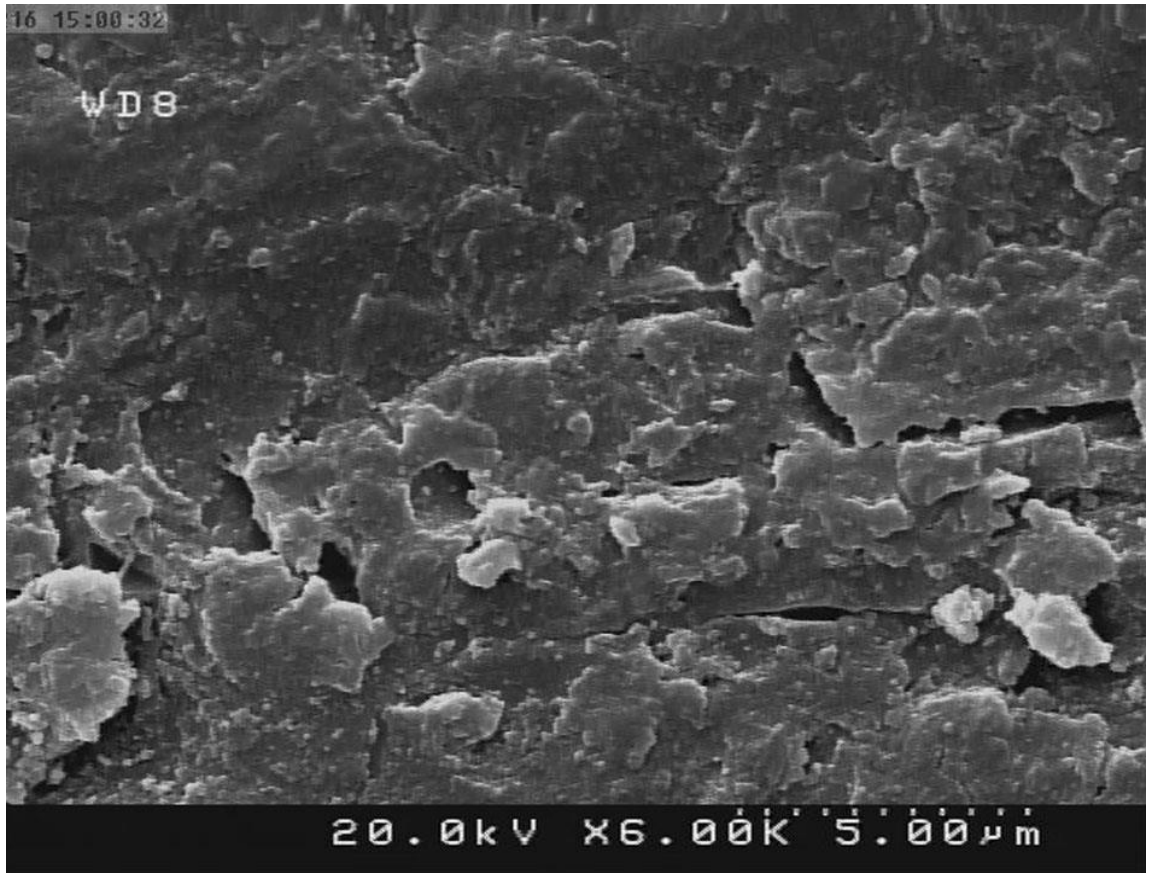


FIG 10: The cross section of coating without CB nanoparticles

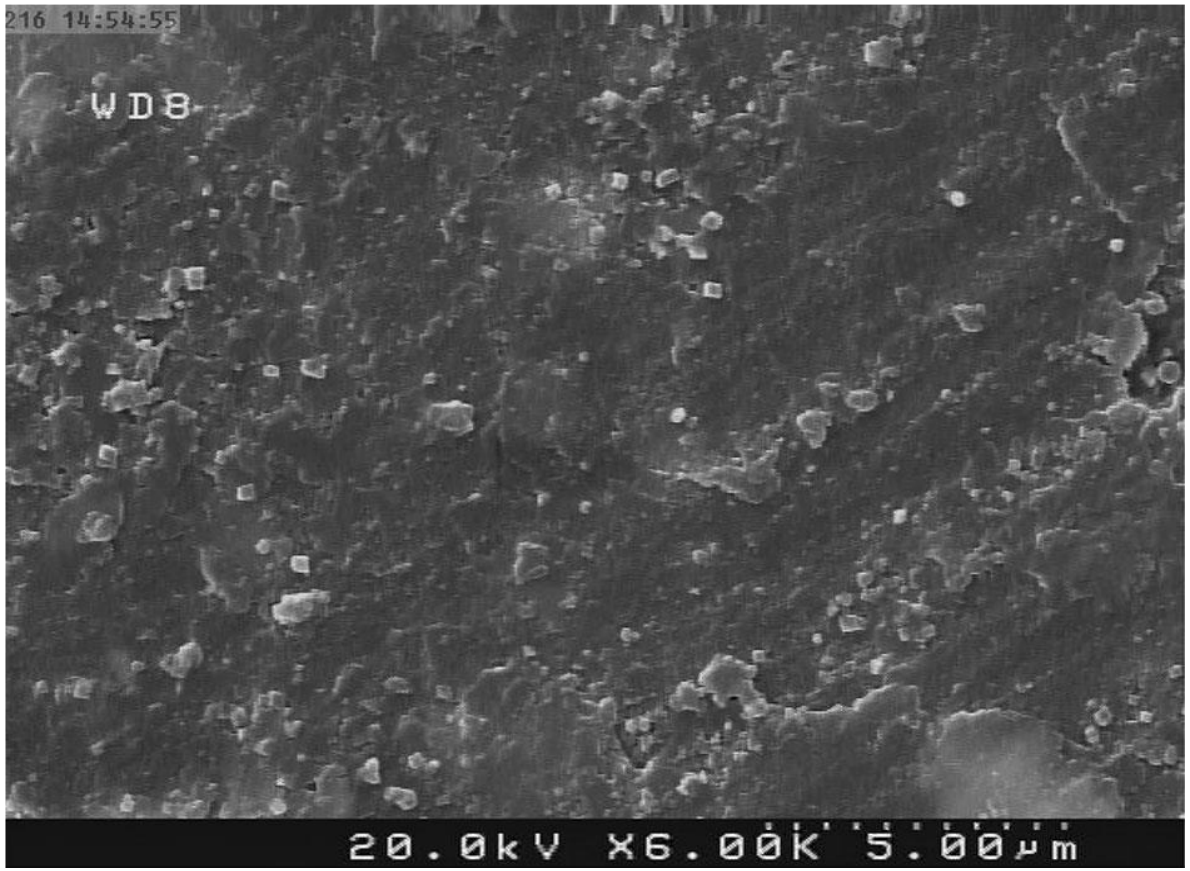


FIG 13: The cross section of coating with 0.75 %wt CB nanoparticles

Conclusions

SDS prevent the agglomeration of CB and FESEM proved that CB nanoparticles modified were dispersed uniformly in solvent

DLS showed that addition of SDS reduces CB size from 220 nm to 100 nm in epoxy solvent.

Zeta potential decreased from -7.2 mV (non-modified CB) to -22.7 mV (modified CB) adding SDS. thus leads to an increase in stability of CB nanoparticles.

TGA showed that more than 20 %wt SDS surfactant was absorbed at the surface of CB nanoparticles

TEM: Non-modified CB has poor dispersion and inhomogeneous, while modified has hight dispertion

The modified CB/epoxy coating was degraded after 3000 h that showed corrosion resistance more than non-modified CB/epoxy which was degraded after 1250 h immersion in corrosive media.

Thank you!