# CNT-based thin sheets: structure, properties and interface

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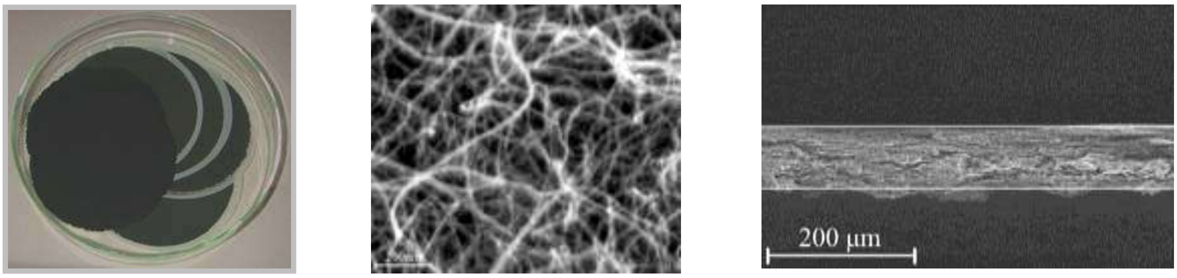
Nanoscale carbon-based materials such as carbon nanotubes (CNTs) have raised muchinterest during the recent years due to their extraordinarymechanical, thermal and electricalproperties[1].Buckypapersarenano-porous,self-standingthinsheetsofcarbonnanotubesandaremadebyrandomlydistributedCNTs[2].Theiraveragethicknesscouldbe intherangeof30-200μm.ThechemicalmodificationofsuchCNTspre-formsisrequiredinorderto couple effectively the unique CNT mechanical/electrical properties with those of the hostpolymer.
OurworkisfocusedonthefabricationofCNT-basedthinsheetsandtheirnanocomposites using automated aerospace processing. Four different modification strategiesofmultiwallCNTs(MWCNTs)wereusedfortreatingtheirgraphiticsurface,namelyhydlochloric acid, nitric acid, ammonium hydroxide/hydrogen peroxide mixture and sulfuricacid/hydrogen peroxide mixture. CNT buckypapers were fabricated following a two stepprocedure; initially, the modified CNTs are dispersed in aqueous media under tip sonicationand then the stable suspensions are filtrated through membrane filters and dried under vacuum(Fig. 1).




(a) (b) (c)

Fig.1:(a)Buckypapers,(b)SEMphotosofbuckypaperfsurfaceand(c)buckypapercrosssection

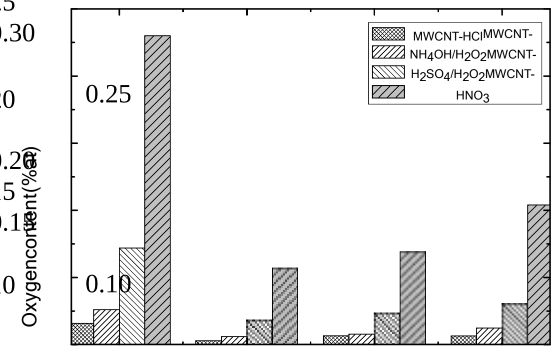
The buckypaper morphology was examined by scanning electron microscopy (SEM) (Fig.1b,c). The oxygen content of modified CNTs was analysed by thermogravimetric (TGA) andX-Ray photoelectron spectroscopy (XPS) techniques. The density of functional groups on thegraphitic network such as carboxylic and hydroxylic was found to be strongly correlated withthe strength of the oxidation agent (Fig. 2a). The pore size distribution (Fig. 2b) studied bymercury porosimetry revealed the presence of two clusters of pore sizes in the buckypapers.The mechanical behaviour was examined by film tensile testing and the results showed that anenhancementoffunctionalgrouppopulationincreasesboththetensilemodulusandstrengthof the films (Fig. 3a). Finally, the nanotube-to-nanotube stress transfer in air was examined bymeansoflaserRamanmicroscopy.Theresultsclearlyindicated(Fig.3b)thatacertainamountofaxial CNTloadingof individualnanotubestakes placeduringfilmtensiletesting.

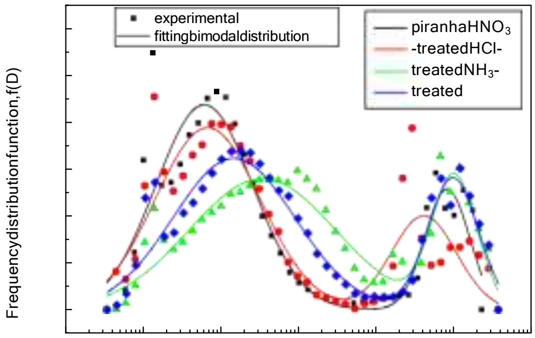
25
0.30

20

0.20
15
0.15

10




5

0
Total
Carboxylates Hydroxylates

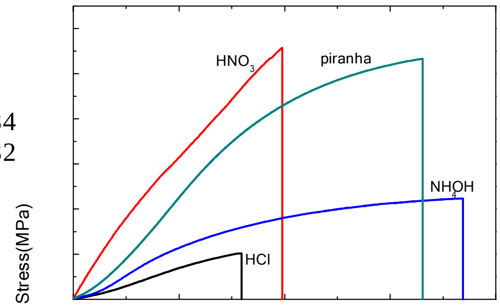
(a)
Phys.ads.

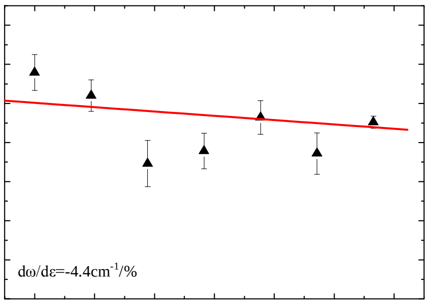
0.05

0.00
1E-3 0.01 0.1 1 10 100
Porediameter,D(μm)
(b) (b)
1000

Fig.2:(a)Oxygencontentofoxidized MWCNTs,(b)Poresizedistributionofbuckypapers

3.0
2.5




2684
2682
2.0

1.5

1.0

0.5

0.0

2680

2678

2676

2674

2672

2670

RamanShift(cm-1)

0.0 0.4 0.8 1.2 1.6
Strain (%)

0.00 0.05 0.10 0.15 0.20 0.25 0.30
Strain(%)

(a) (b)

Fig. 3: (a) Mechanical behaviour of oxidized buckypapers, (b) Wavenumber shift of the second order peak at2680 $cm^{-1}$ofbuckypaperoxidizedwith$HNO_3$under tensilestrain.

## REFERENCES

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