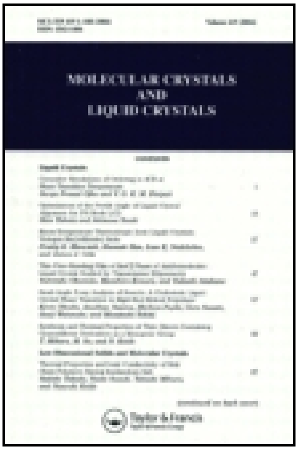


Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

Electrical Properties and Thermal Stability of Electrically Conductive Composites

Dong-Il Kang [b], Jae-Wan Kim [a], Won-Jei Cho [a] & Chang-Sik Ha [a]

[a] Department of Polymer Sci. & Eng., Pusan National University, Pusan, 609-735, Korea

[b] Agency for Defense Development (IKI-3-7) Yuseong, P.O.Box 35-5, Taejon, 305-600, Korea

To cite this article: Dong-Il Kang, Jae-Wan Kim, Won-Jei Cho & Chang-Sik Ha (2000): Electrical Properties and Thermal Stability of Electrically Conductive Composites, Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals, 349:1, 351-354

To link to this article: http://dx.doi.org/10.1080/10587250008024936

Mol. Cryst. and Liq. Cryst., 2000, Vol. 349, pp. 351-354
Reprints available directly from the publisher
Photocopying permitted by license only

Published by license under the
Gordon and Breach Science Publishers imprint.
Printed in Malaysia

Electrical Properties and Thermal Stability of Electrically Conductive Composites

DONG-IL KANG[b], JAE-WAN KIM[a], WON-JEI CHO[a] and CHANG-SIK HA[a]

[a]*Department of Polymer Sci. & Eng., Pusan National University, Pusan 609–735, Korea and* [b]*Agency for Defense Development (1KI-3–7) Yuseong P.O.Box 35–5, Taejon, 305–600, Korea*

Electrically conductive polypyrrole(PPy)-poly(N-methylpyrrole) (PNM P) composites were prepared by electrochemical polymerization of the corresponding monomers at a platinum electrode surface in 0.036M sodium dodecylsulfate(NaDS)/distilled water(H_2O) electrolyte solution system. Two types of composites were prepared and characterized by TGA, SEM, and 4-probe meter.

Keywords: electrochemical polymerization; conductive composites; polypyrrole; electrolyte solution

INTRODUCTION

Since the discovery of electrochemical polymerization of conducting polymers[1], electrically conducting polymers have attracted great attention because of their electronic properties which enable their application in several technological sectors. Among conducting polymers, polypyrrole (PPy) can readily be obtained in its conducting form by electrochemical oxidation of pyrrole[2].

However, little attention has been paid to bilayer conducting polymer films. The concept of bilayers of polymer films was first introduced by Murray's group[3]. In this work, Ppy-Poly(N-methyl pyrrole) (PNMP) composites were prepared.

EXPERIMENTAL

Pyrrole and N-methylpyrrole obtained from TCI Chem. Co. were purified by vacuum distillation and stored in the dark at low temperature before use. Sodium dodecylsulfate(NaDS) was of certified analytical grade obtained from Aldrich.

Electrodeposition of bilayer films (PNB and NPB) were prepared in two steps: Typically, for PNB composite, pyrrole was electropolymerized onto the electrode surface galvanostatically at 20.0 $mAcm^{-2}$ using 0.036M NaDS/H_2O electrolyte solution during the 1000 seconds; secondly, N-methylpyrrole was also electropolymerized on the previous PPy film layer, which has been covered on the platinum electrode by the same procedures as described above. For NPB composite, the top and bottom of the bilayer is reversed. Monomer mixture conducting polymer composites were electropolymerized onto the electrode surface galvanostatically at 20.0$mAcm^{-2}$ using 0.036M NaDS/H_2O electrolyte solution containing 0.36M pyrrole and 0.36M N-methylpyrrole monomer, during 1000 seconds. In the case of the monomer mixture conducting polymer composites, the monomer contents were varied as 1:1, 2:1, and 1:2 by volume/volume. The Notations are P1N1, P2N1, and P1N2 composites, respectively.

Thermal stabilities of the composite films were examined by TGA(DuPont 2100). The electrical resistances of the composite films were measured by the standard four-point technique. The morphologies of the electrode side of the composite films were observed by using SEM(JEOL JSM 5200).

RESULTS AND DISCUSSION

Table 1 shows the resistance values of composites prepared in NaDS/H_2O electrolyte solution system by electropolymerization. In this case, PNMP homopolymer shows lower conductivity than PPy homopolymer. Both PNB and NPB films showed intermediate resistance values between those of corresponding homopolymers. This indicates that for the bilayer composites the outer layer might interpenetrate into the inner layer on the platinum electrode through the interface by some degree of interaction or reaction between the two homopolymers during the electropolymerization.

The monomer mixture conducting composites showed simply intermediate or additive electric resistance values between those of the two homopolymers; The resistance value was increased with N-methylpyrrole content.

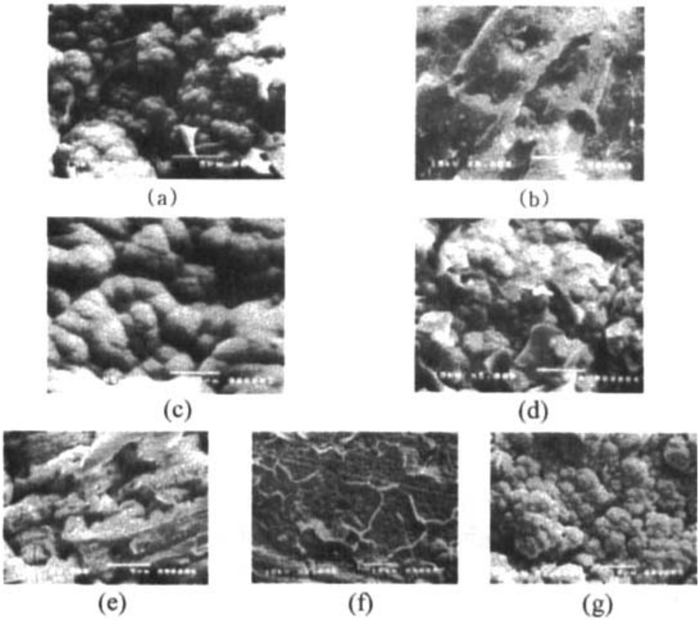
TABLE 1. The resistance values and thermal stability of samples prepared in NaDS/H2O electrolyte solution system

Samples	Resistance(Ω)	TID(^{0}C)
PPy homopolymer	65.75	162.85
PNMP homopolymer	1723.45	126.29
PNB composite	103.85	158.56
NPB composite	802.80	149.15
P1N1 composite	372.43	124.11
P2N1 composite	130.57	129.82
P1N2 composite	636.10	125.30

Table 1 also shows the thermal stability of composites. PPy homopolymer shows higher temperature of initial decomposition(TID) than PNMP homopolymer. Bilayer conducting polymer films exhibited higher TID's than those of monomer mixture conducting polymer composites regardless of the sequence of the bilayer. The bilayer conducting polymer films showed simple additive thermal stability of the individual polymers. But monomer mixture conducting polymer composites showed slightly different thermal stability and lower TID's being close to or lower than that of PNMP homopolymer as compared with bilayer films. The thermal stability decreased with increasing N-methylpyrrole contents. It should be noted from Table 1, however, that the PNB composite shows better electric conductivity and good thermal stability than any other composite films, regardless of the preparation methods.

Figure 1 shows morphological changes of the composites. One can easily see that the tendency of the interpenetration or the reaction between different homopolymers are larger in the case of P1N1 than in the bilayer conducting polymer films having the same polymer contents.

The difference in their morphologies may be attributed to the fact that the possibility reactions take place is much larger for the P1N1 than for the bilayer polymer films, since the in-situ formation of the P1N1 starts from the monomer mixture.



----- 5 μm (× 5,000)

FIGURE 1. SEM micrographs of PPy/PNMP composites prepared in 0.036M NaDS/H_2O solution electrolyte system
(a) PPy (b) PNMP (c) PNB (d) NPB
(e) P1N1 (f) P2N1 (g) P1N2

References

[1] A.F.Diaz, K.K.Kanazawa and G.P.Gardini, *J.Chem.Soc.,Chem. Commun.*, 635 (1979).
[2] D.I.Kang, W.J.Cho, H.W.Rhee and C.S.Ha, *Synth.Met.*, 69, 503 (1995).
[3] H.D.Abruna, P.Denisevich and R.W.Murray, *J.Am.Chem.Soc.*, 103, 1 (1981).