تصنيع متحسس (بوليمر – نيكل) شفاف كهروميكانيكي

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الخلاصـة

استخدمت البوليمرات فـي الآونـة الأخيرة في مجالات تطبيقية الكترونية متعددة بوصفها موادا موصلة للكهربائية ونافذة (شفافة) للضوء معاً. حضرت في هذا البحث أغشية بوليمرية بسمك (1) ملم واقل منه حاوية على مسحوق النيكل المعدني وعولجت قبل تصلبها في مجال مغناطيسي داخل فرن مفرغ من الهواء بدرجة حرارة 120 درجة مئوية لترتيب او توجيه دقائق مسحوق النيكل في الاساس البوليمري وتهيئته للنقل الاتجاهي للكهربائية. أظهرت هذه الأغشية قابليتها للتحسس الى أي حمل يوضع على السطح (قوة لوحدة المساحة).

ان استعمال الاحمال الخفيفة ووضعها على وحدة الخلية الكهربائية لهذه الاغشية تمكننا من الحصول على متحسس كهربائي شفاف، الذي من الممكن استخدامه في دوائر تحسس الكهربائية التطبيقية .

Forming Electro - Mechanical Transparent (Polymer -Ni) Sensor

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Abstract

Polymers (Silicon elastomer) are used lately as a conductive material in electronic application in addition to be transparent, to light. In this paper we prepared polymer films about (1mm) thick and less which contain Ni-metal powder cured in magnetic vacuum furnaces at temperature 120°C in order to arrange or to be oriented the particles of the Ni-powder through the polymer in such a way to be conductive for electric currents. We found that these films are sensitive to any loads on the surface (force per unit area). Using light loads on a unit electric cell from these films, we get an electric transparent sensor that could be used in sensing applications.

Keywords: Polymers, Ni-powder, electrical sensor

Introduction

Optically transparent but electrically conductive materials are useful for a variety of visual communication, sensor, and electronic device applications. [1] Transparent materials are in general electrical insulators or high resistively semiconductors because they have very low mobile charge carriers. Although some composite materials (such as glass coated with thin transparent metal) have both transparency and electrical conductivity, which is useful for a variety of device applications [2].

In order to create a transparent sheet with vertical conducting paths, we utilized magnetic field alignment of conductive ferromagnetic particles in a transparent matrix material. When ferromagnetic spheres randomly dispersed in a viscous medium are subjected to directional magnetic fields, they move and align themselves into a chain configuration to minimize the magneto static energy. The matrix material such as glass, silicon elastomer, epoxy resin and so forth can be cured with a metal led to a composite structure that both optically and electrically an isotropic [3, 4] .

Experimental

Approximately weight fraction 10-65% of Ni- powder with an average diameter of about 20 um was thoroughly mixed by rule of mixtures with optically transparent, uncured silicon elastome witch was provided by General Company of Chemical Industry. The mixture was spread on a flat glass substrate and a doctor blade was used to form a thin Layer about (1mm) thick and less than; then it was heat -cured (120°C for 15min with 10^{-2} mbar vacuum) in vacuum oven with the presence of vertical magnetic field of about 0.2 mT. The cured sheet was peeled off the substrate and tested for optical and electrical properties [5, 6].

Results and Discussion

We measured the electrical conductivity of the composite medium in the X – Y directions by using four probe techniques. We found from the obtained results that the conductive material changes according to the film thickness. That means when we use a thicker film, the conductive decreases, due to the alignment of particles inside the furnace through the magnetic area in comparison with thickness.

Fig (1-a) shows the structure of the electric unit cell circuit used for the composite film. The composite sheet was sandwiched between two circuit boards (myler sheet) coated with Al. Avominal pressure (we use this term to determine the affected pressure on the film, which is a pressure resulted from a local pressure as a head pen or a thumb)as in fig (1-b) was applied during the measurement to ensure good contacts between metal spheres so the average through resistance of the composite medium was measured so small between 1 and 2 points [7].

Fig. (2) indicates the changing of electrical conductive by outside pressure (load) on the Nickel particles, which get a conductive we can use in film sensors. We noticed that the electrical conductivity increases due to the decreas of electrical resistance when increasing the load to a particular value, which depends on the film thickness and its method of preparing. Thus, beyond this value, this film will lose its feature.

The phenomenon of particles alignment or Nickel atoms in the medium of insulated polymers which is called (percolation effect) that leads to the change of Nickel – polymer to a conductive medium because the polymer here should characterize with a sort of flexibility, so the atoms can move and return to the zero point (the beginning) when the external effect vanishes.

The weight fraction of Nickel in polymer (as a volume) plays a role in determining the value of electrical conductive of the prepared film. In fig. (3), the optical microscope picture indicates the effect range of Nickel concentration in the medium of polymers upon the film transparency to light in addition to conductive. We found that there was a relation between Nickel concentration and its distribution inside the film on the electrical – mechanical conductive. The increasing of Nickel concentration does not mean increasing of conductive unless the atoms alignment allow to electrical sign to pass through an external load that pushes the atoms closer and deletes the internal gaps, and that leads to getting the electrical sign. That depends on the Nickel atoms array of the film inside the furnace after the thermal treating.

Conclusion

An optically transparent, Z- direction conductive medium such as described here may be useful as a pressure sensor for visual communication devices such as a write pads or finger – touch sensitivity display screens. The feasibility of the device depends on the concentrations of composite medium containing about 1% by volume of the particles.

Reference

1.Eur, J. (1999) "Self – Assembled Monolyers as Interface for Organic Opto-Electronic Devices". Phys. Bll 505:512 .

2.Nicastro, A. J. (1983) "Demonstrations of Some Optical Propeties of Liquid Crystals". Phys. Tech. 21: 181.

3.Martin, S. J. ; Kambili, A. and Walker, A. (1977) "Temperature and Field Dependence of the Mobility in liquid Crystal-Crystalline Conjugated Polymer Films", Advances in Electrically Conductive Materials, Calverton Down, UK

4.Berger, K. E. and Donald, S.D. (1988) "Journal of Materials Science", 23(4): 1368

5. Collins,P. J. (1990), "Liquid Crystals Nature Delicate Phase of Matter", Princton University, Press, Princton.

6.Kleja, P. U. (1987) "Liquid Crystal Physics", Encyclopedia of Physical Scienmce and Technologe, Academic Press 7:365.

7.Braum, D.; Cherobon, H. ; Rehahn, M.; Riher, H. and Voits, B. (2005) "Polymer Synthesis Theory and Practice", Springer-verlay Berlin Heidberg,, P.154 .

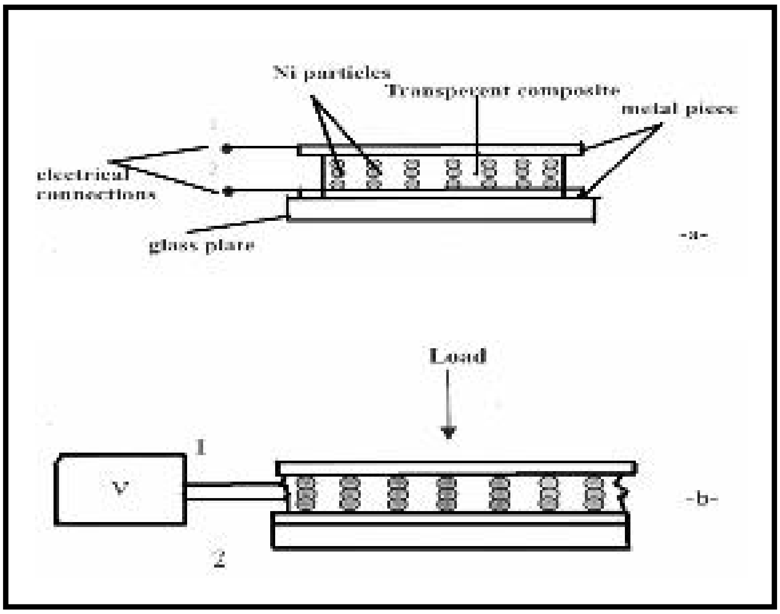

Fig. (1): Diagram of electric unit cell circuit used the (polymer – Ni) film (a): before and (b): after a local pressure applied

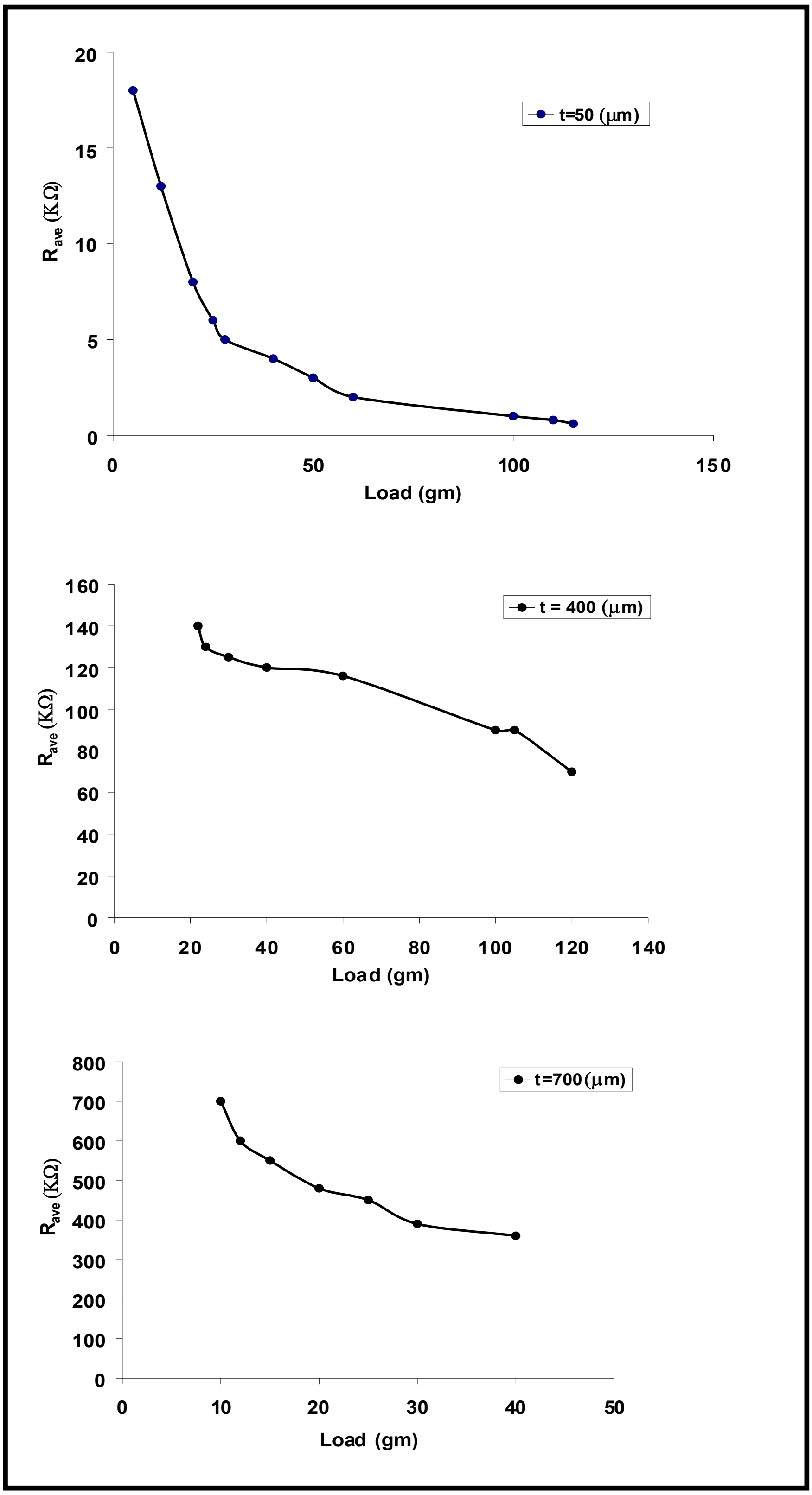

Fig. (2): Shows the relation between the average resistance and a local load applied for the three different thickness films

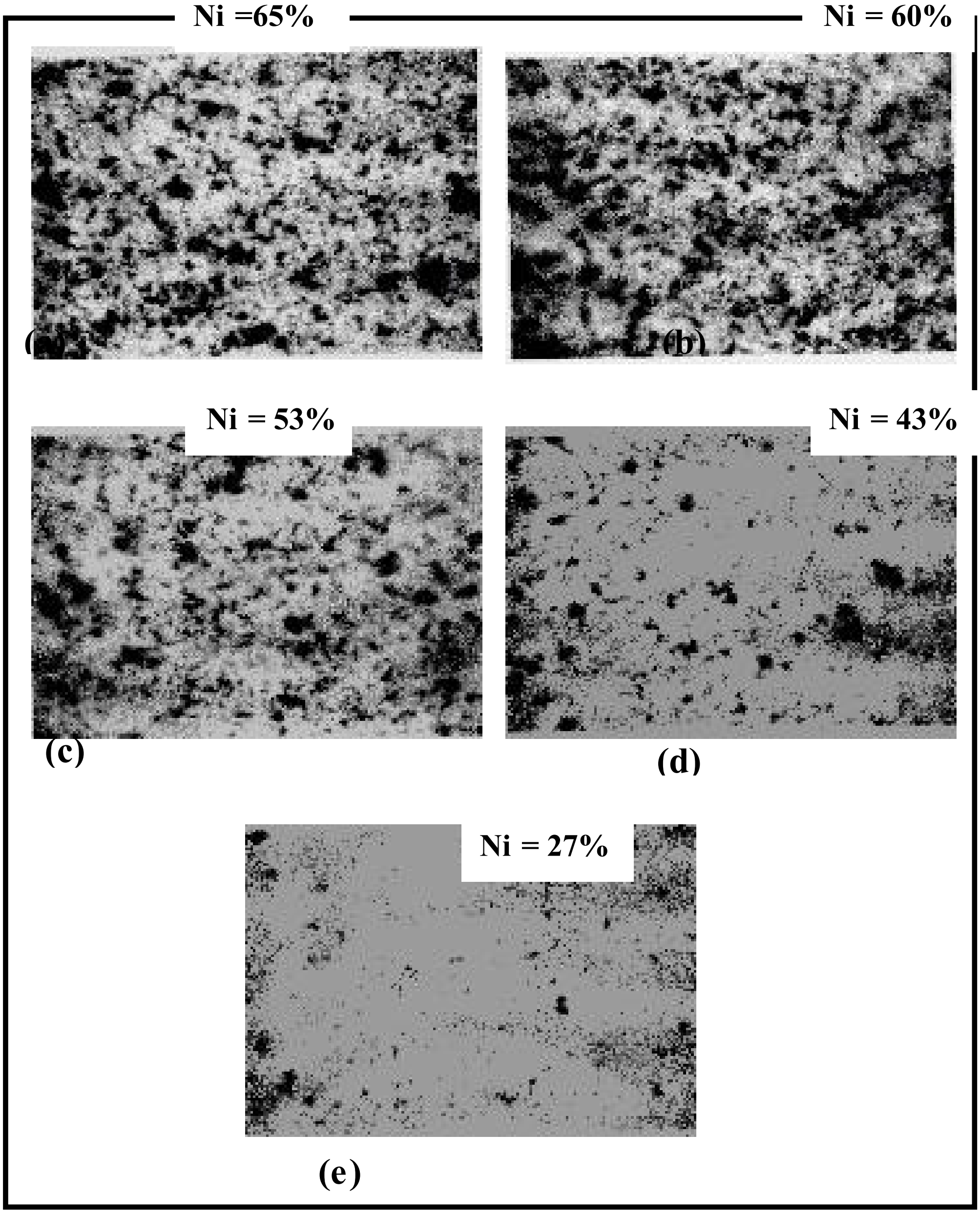

Fig. (3): The E.M. picture of the film transparency at different weight fraction of Ni in silicon elstomer