P-192: Porous fiber filled by liquid crystal for flexible displays and E-paper technology

V.I. Mashchenko
Lomonosov Moscow State University, Chemistry Department, Moscow, Russia +7 (095) 939 31 15, Mashchenko@genebee.msu.su

S.A. Udra, V.V. Sorokin*, V.I. Gerasimov*, V.V. Belyaev***
*** Lomonosov Moscow State University, Chemistry Department, Moscow, Russia**
**** Cometa central R & D Institute Moscow, Russia**

Abstract

In this paper, we report new technique of preparation of material for flexible displays and E-paper technology. This material represents porous polymeric fiber based on polyacrylonitrile filled by liquid crystal.

1. Objectives and Background

There is currently considerable interest in flexible displays and E-paper. Many electronic based companies currently are actively researching flexible displays and E-paper based on liquid crystal (LC).

Liquid-crystalline composites (LC-composites) (for example PDLC) [1, 2] are widely used in electro-optical displays and other optical devices [2, 3], because of possibility to change optical state of the system by effect of temperature or electrical field as "muddy – transparent". Large amount of works [1, 4] is dedicated to investigation of different properties of the LC-composites. Formations of the composite's structure, which may provide of obtaining of optimal optical characteristics of device, attach high importance [5].

In the previous works [6, 7, 8] were developed new method of obtaining of the LC-composites. By this approach the structure of the LC-composite's matrix is determined by the morphology of initial polymer gels. Structure of the matrix based on the polymer gel represents a spatial net of macromolecules connected by molecular forces with different nature. It was shown in the works [7, 8], that properties of the LC in the composites may regulate by varying of the morphology of the gels.

In the work [9] the samples of the composites were subjected to a deformation by a method of the zone stretching. The maximal linear elongation is 2000%. It was shown by methods of X-ray diffraction and IR-spectroscopy in the polarized radiation, which the orientation of the material of the matrix and LC molecules occurs in the direction of the axis stretching, order parameter of the MBBA molecules growing with increase multiplicity of stretching.

The aim of this work is to investigate of structure of matrix of the oriented LC-composites based on polyacrylonitrilic (PAN) gels and LC - N-(4-Methoxybenzylidene)-4-butylaniline (MBBA).

2. Results

The researches carried out with high molecular mass atactic PAN ($M = 2 - 2.5*10^6$), N-(4-Methoxybenzylidene)-4-butylaniline (MBBA), chemical purity 98% obtained from Aldrich Chemical Company (temperatures of phase transitions from crystal to nematic = 19°C and from nematic to isotropic liquid (TNI) = 38°C).

The morphology of the samples was investigated by the scanning electron microscope S - 520 (HITACHI, Japan).

In the previous works [6, 7] were shown, that the morphology of the polymeric matrices properly depends from temperature of the gel's formation. In this work the gels with the sizes of pores 15 nm were prepared. The scanning electron microscopy photograph are made from xerogels ("xero" (Latin) – dry, i.e. gel after evaporation of a solvent) are presented in Fig. 1.

It is visible, that morphology of the investigated xerogels is rather homogeneous in volume.

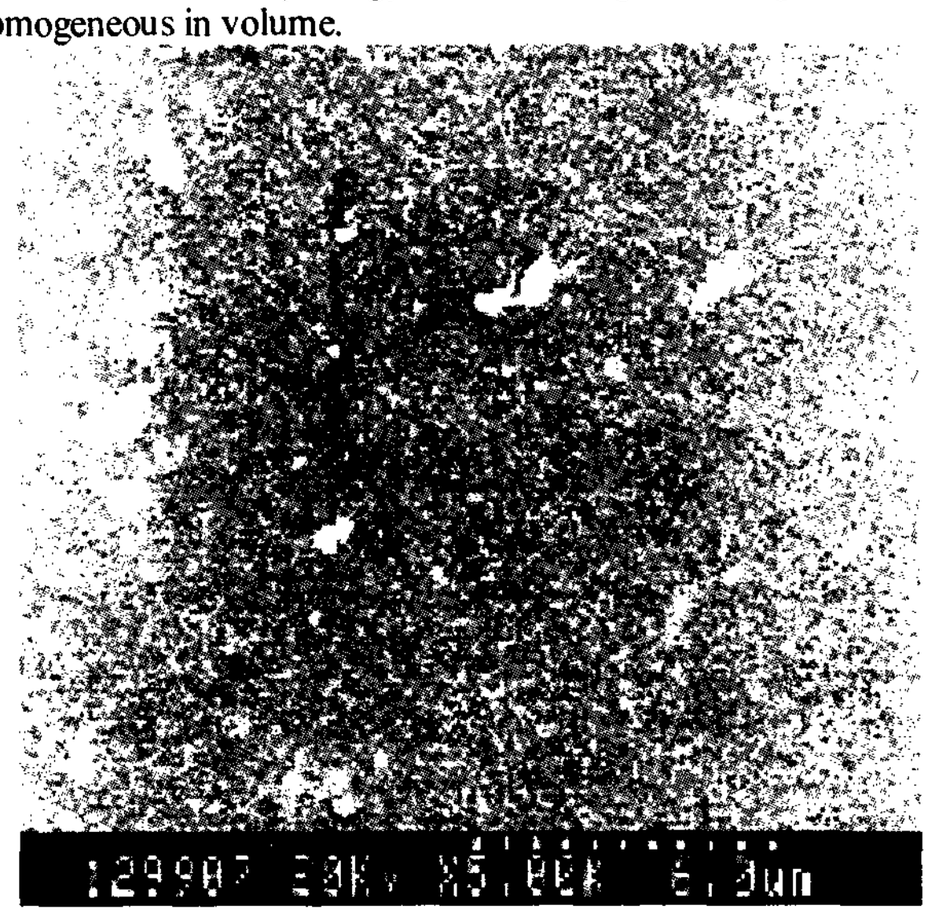
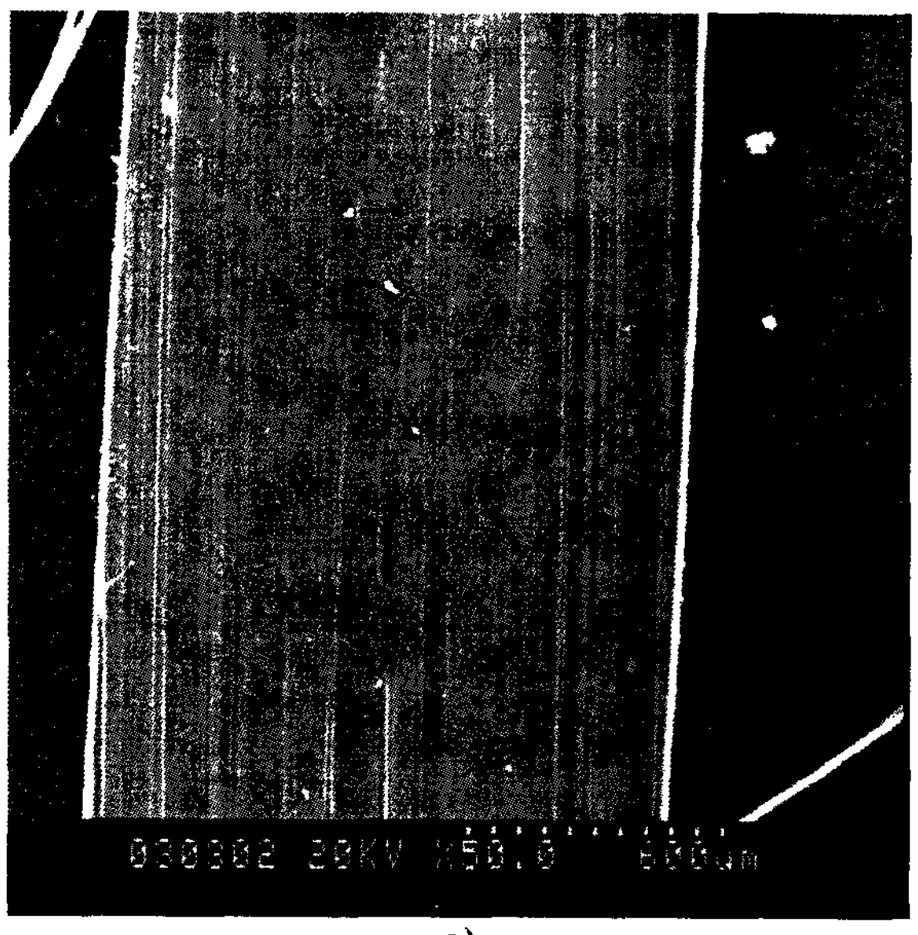
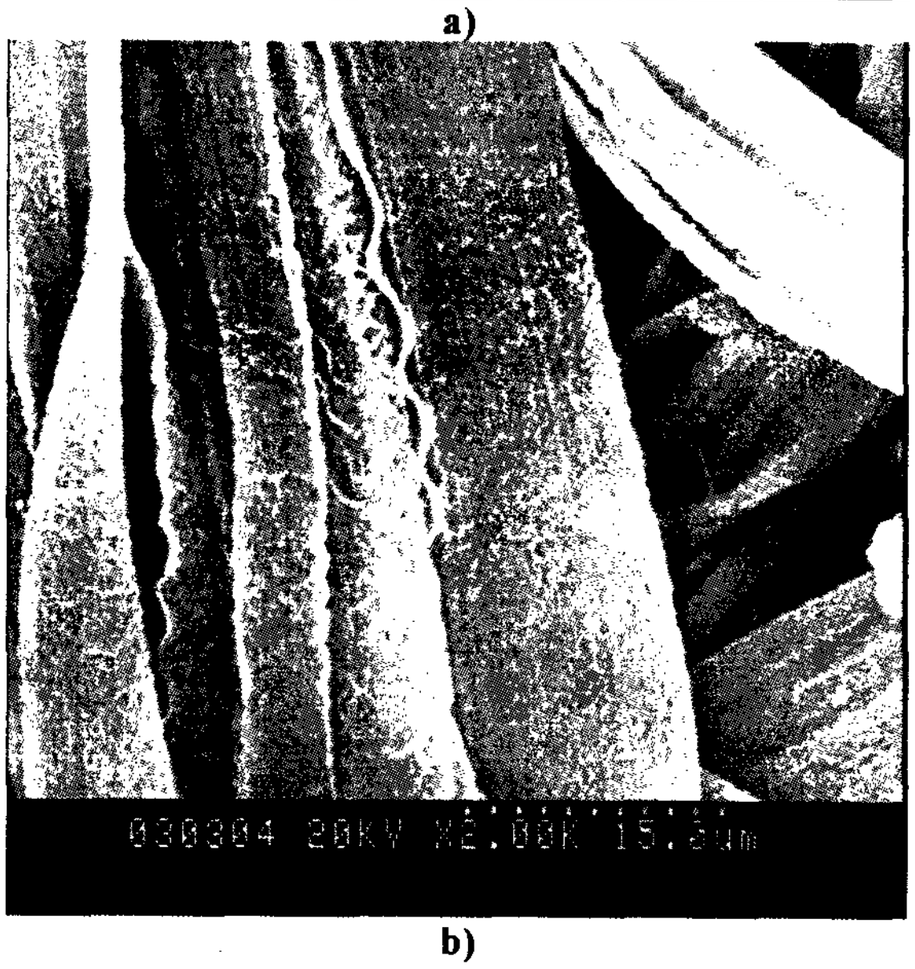


Figure 1. Scanning electron microscopy photograph was made from the xerogels, obtained from the gels formed at -30°C.

Replacement of the solvent was required for obtaining the LC-composites on the basis of prepared gels. Initial solvent was replaced on the solvent with low boiling temperature and then on the resolution of MBBA. After that the solvent was evaporating in vacuum. The content of the LC in composites was 90 %. The samples of the composites were subjected to a deformation by a method of the zone stretching. The maximal linear elongation is 2000%. Then the LC was removed from polymer matrix and the structure of matrix was investigated by scanning electron microscope.



a)



b)

Figure 2. Scanning electron microscopy photographs was made from the xerogels, obtained from the LC-composite. a) – surface, b) – bulk.

It is visible, that the surface of the investigated xerogel, obtained from the LC-composite is rather homogeneous and nonporous, whereas the bulk of this sample is high dispersive, high porous and have fiber-like structure.

Such structure of this material is very useful for filling by LC and further application because of:

- Porous structure of bulk allow to fill it by LC;
- Nonporous surface permit to save LC in bulk;
- Fiber-like structure allows making planar orientation of LC.
- Fiber-like structure permits to high mechanical strength.

3. Impact

Porous fibers filled by liquid crystals based on PAN combine high mechanical properties of big-volume polymer and cheap technology of possible production of flexible displays and E-paper.

4. Acknowledgements

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