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(54) **METHOD FOR ENCAPSULATING AN ELECTRONIC ARRANGEMENT**

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C09J 153/02 (2006.01)

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CPC ***H01L 51/5246*** (2013.01); ***C09J 153/02*** (2013.01); ***C09J 153/025*** (2013.01); *Y10T 428/2835* (2015.01)

(58) **Field of Classification Search**
USPC 264/271.1, 272.11, 272.17
See application file for complete search history.

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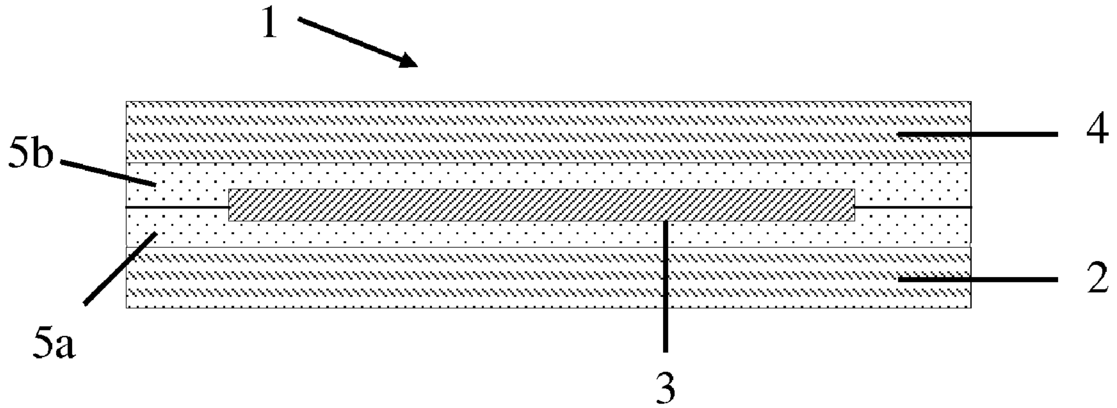
(57) **ABSTRACT**

The present invention relates to a method for encapsulating an electronic arrangement against permeants, in which a pressure-sensitive adhesive composition based on vinylaromatic block copolymers is provided, and in which the pressure-sensitive adhesive composition is applied onto and/or around the regions of the electronic arrangement which are to be encapsulated.

22 Claims, 2 Drawing Sheets



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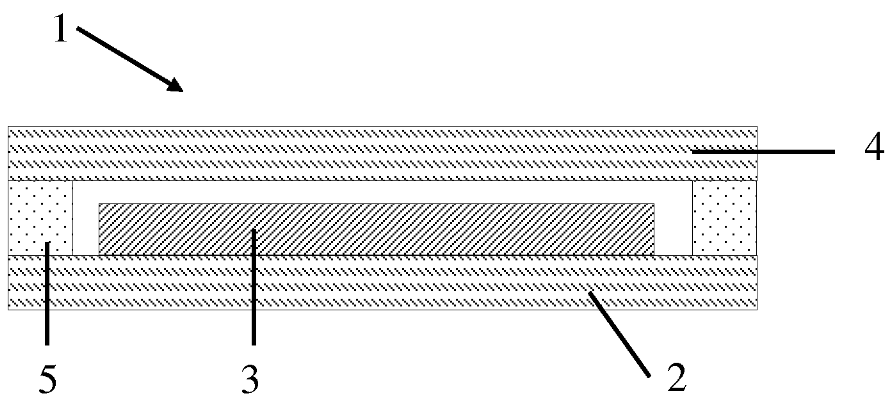

Fig. 1

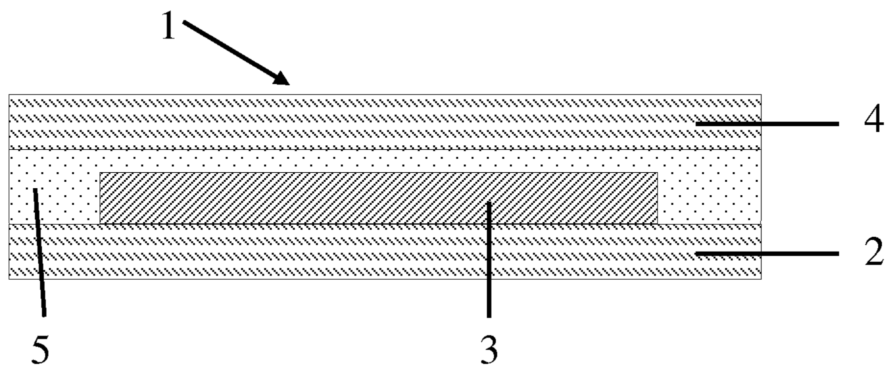

Fig. 2

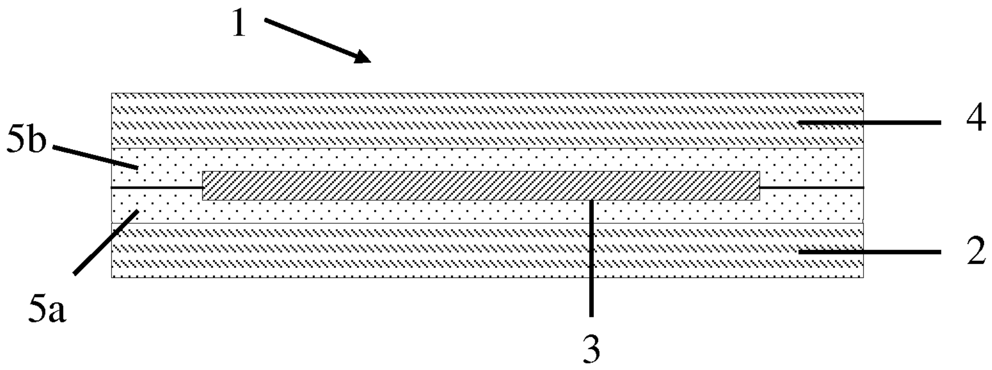

Fig. 3

METHOD FOR ENCAPSULATING AN ELECTRONIC ARRANGEMENT

The present invention relates to a method for encapsulating an electronic arrangement in accordance with the preamble of Claim **1** and to the use of a pressure-sensitive adhesive composition for encapsulating an electronic arrangement in accordance with the preamble of Claim **5**.

(Opto)electronic arrangements are being used more and more often in commercial products or are about to be introduced to the market. Such arrangements comprise inorganic or organic electronic structures, for example organic, organometallic or polymeric semiconductors or else combinations thereof. Depending on the desired application, these arrangements and products are embodied in rigid or flexible fashion, where there is an increasing demand for flexible arrangements. Such arrangements are produced for example by printing methods such as relief printing, intaglio printing, screen printing, planographic printing or else so-called "non impact printing" such as, for instance, thermal transfer printing, inkjet printing or digital printing. In many cases, however, use is also made of vacuum methods, such as e.g. chemical vapour deposition (CVD), physical vapour deposition (PVD), plasma-enhanced chemical or physical deposition methods (PECVD), sputtering, (plasma) etching or vapour deposition, wherein the patterning is generally effected by means of masks.

Examples that may be mentioned here of (opto)electronic applications that are already commercial applications or are interesting in terms of their market potential include electrophoretic or electrochromic structures or displays, organic or polymeric light-emitting diodes (OLEDs or PLEDs) in indication and display devices or as lighting, electroluminescent lamps, organic solar cells, preferably dye or polymer solar cells, inorganic solar cells, preferably thin-film solar cells, in particular based on silicon, germanium, copper, indium and selenium, organic field effect transistors, organic switching elements, organic optical amplifiers, organic laser diodes, organic or inorganic sensors or else organically or inorganically based RFID transponders.

What can be regarded as a technical challenge for realizing sufficient lifetime and function of (opto)electronic arrangements in the field of inorganic and/or organic (opto) electronics, but especially in the field of organic (opto) electronics, is protecting the components contained therein against permeants. Permeants can be a multiplicity of low-molecular-weight organic or inorganic compounds, in particular water vapour and oxygen.

A large number of (opto)electronic arrangements in the field of inorganic and/or organic (opto)electronics, especially when using organic raw materials, are sensitive both to water vapour and to oxygen, where the penetration of water vapour is rated as a fairly major problem for many arrangements. Protection by means of an encapsulation is necessary during the lifetime of the electronic arrangement, therefore, since otherwise the performance deteriorates over the application period. Thus, for example as a result of an oxidation of the constituents for instance in the case of light-emitting arrangements such as electroluminescent lamps (EL lamps) or organic light-emitting diodes (OLED) the luminosity, in the case of electrophoretic displays (EP displays) the contrast or in the case of solar cells the efficiency can decrease drastically within a very short time.

In the case of inorganic and/or organic (opto)electronics, in particular in the case of organic (opto)electronics, there is water vapour. In addition, there are a large number of further requirements for such (opto)electronic arrangements. The flexible adhesive solutions are therefore intended not only to achieve a good adhesion between two substrates, but additionally to fulfil properties such as high shear strength and peel strength, chemical resistance, ageing resistance, high transparency, simple processability and also high flexibility and pliability.

One approach that is common according to the prior art is therefore to place the electronic arrangement between two substrates that are impermeable to water vapour and oxygen. Afterwards, sealing is then effected at the edges. For inflexible structures, glass or metal substrates are used, which offer a high permeation barrier but are very susceptible to mechanical loading. Furthermore, these substrates cause the entire arrangement to have a relatively large thickness. In the case of metal substrates, moreover, there is no transparency. For flexible arrangements, by contrast, use is made of planar substrates, such as transparent or non-transparent films, which can be embodied in multilayer fashion. Combinations of different polymers as well as inorganic or organic layers can be used in this case. The use of such planar substrates enables a flexible, extremely thin construction. In this case, a wide variety of substrates such as e.g. films, woven fabrics, nonwovens and papers or combinations thereof are possible for the various applications.

In order to achieve a best possible sealing, special barrier adhesive compositions are used. A good adhesive composition for the sealing of (opto)electronic components has a low permeability to oxygen and in particular to water vapour, has a sufficient adhesion on the arrangement and can flow well on the latter. A low adhesion on the arrangement reduces the barrier effect at the interface, thereby enabling oxygen and water vapour to enter independently of the properties of the adhesive composition. It is only if the contact between composition and substrate is continuous that the properties of the composition are the determining factor for the barrier effect of the adhesive composition.

In order to characterize the barrier effect, the oxygen transmission rate OTR and the water vapour transmission rate WVTR are usually specified. In this case, the respective rate indicates the area- and time-related flow of oxygen and water vapour through a film under specific conditions of temperature and partial pressure and, if appropriate, further measurement conditions such as relative air humidity. The lower these values, the better the suitability of the respective material for encapsulation. In this case, the specification of the permeation is not only based on the values for WVTR or OTR but also always includes a specification with regard to the average path length of the permeation, such as e.g. the thickness of the material, or a normalization to a specific path length.

The permeability P is a measure of how permeable a body is to gases and/or liquids. A low P value denotes a good barrier effect. The permeability P is a specific value for a defined material and a defined permeant under steady-state conditions for a specific permeation path length, partial pressure and temperature. The permeability P is the product of diffusion term D and solubility term S:

$$P=D*S$$

The solubility term S in the present case describes the affinity of the barrier adhesive composition for the permeant. In the case of water vapour, for example, a low value is achieved for S by hydrophobic materials. The diffusion term

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