require a separate cross-linking operation to be carried out at the same time or after the formation of the conductive path.

2. After production and cross-linking, a permanent stress can be created along the required conductive path. This can be done by causing the path to shrink using a focussed source of radiation. This can be followed by mechanical compression of the irradiated pathways to consolidate the conductive content and improve the final conductance of the path.
3. Laying polymer or adhesive, which shrinks as it cross-links or dries, on top of or within the conductive polymer composition or structure, would make the underlying. polymer composition conductive.
4. In sheets of conductive polymer composition and materials coated with conductive polymer composition a line of stitching can apply sufficient force within and between the stitches to create a conductive path. Thin plastic foams coated with conductive granules are particularly good materials for this form of the invention and flexible, touch-sensitive circuits can be produced by this method. The thread used for the stitching can be of a standard non-conductive type and the size and tension of the stitch has an effect on the final resistance of the path. Threads containing conductive material can be used if paths with very low resistance are required. Sheets can be produced with conductive tracks with an open-cell foam or other dielectric to keep the sheets apart until an actuating pressure is applied to bring the sheets into mutual conduction.

The invention in its third aspect relates to polymeric sensing materials and in particular to a sensor based on the stress-sensitive electrically conductive polymer compositions such as those detailed in the above cited prior patent applications.

Surprisingly it has been found that the above mentioned polymer compositions, modified polymers and structures, change electrical property by interaction with chemical, biological species, nuclear and electromagnetic fields. The change in electrical property is reversible and may give a measure of concentration of radiation flux.

According to the invention a sensor for chemical species or biological species or radiation comprises:

a) a contacting head presenting a polymer composition comprising at least one substantially non-conductive polymer and at least one electric conductive filler and being electrically insulating when quiescent but conductive when subjected to mechanical stress or electrostatic charge;

b) means for access of a test specimen to the head;

c) means to connect the head into an electrical circuit effective to measure an electrical property of the polymer composition.

It is noted that in the polymer composition the encapsulant phase is highly negative on the triboelectric series, does not readily store electrons on its surface and is permeable to a range of gases and other mobile molecules into the head and/or onto its surface, thus changing the electrical property of the polymer composition.

In the contacting head the polymer composition may be for example in any of forms (a) to (c) above.

The contacting head may include stressing means, for example mechanical compressing or stretching or a source of electric or magnetic field, to bring the polymer composition to the level of conductance. appropriate to the required sensitivity of the sensor.

The sensor may afford static or dynamic contacting. For static contacting it may be a portable unit usable by dipping the head into the specimen in a container. For dynamic conducting, it may be supported in a flowing current of specimen or may include its own feed and/or discharge channels and possibly pump means for feeding and or withdrawing specimen. Such pump means is suitably peristaltic as, for example in medical testing.

In one example the properties of the system change in real time. That is, under the influence of a non-uniform electric field the particles experience an electrophoretic force which changes the electrical property of the polymer structure.

In a preferred sensor the polymer composition is excited by a linear or non-linear AC field. A range of techniques may be used to distinguish the signal of interest from noise and from interfering signals, for example—reactance, inductance, signal profile, phase profile, frequency, spatial and temporal coherence.

In another example the polymer composition is held in a transient state by application of an electric charge; then increased ionisation as a consequence of exposure to nuclear radiation changes the electrical resistivity, reactance, impedance or other electrical property of the system.

In a further example a complexing ionophore or other lock and key or adsorbing material is incorporated within the polymer composition. Such materials include crown ethers, zeolites, solid and liquid ion exchangers, biological antibodies and their analogues or other analogous materials. When excited by a DC, linear AC or non-linear AC field, such materials change their electrical property in accordance with the adsorption of materials or contact with sources of radiation. Such materials offer the potential to narrow the bandwidth for adsorbed species and selectivity of the system. In a yet further example an electride, that is a material in which the electron is the sole anion, a typical example of which might be caesium-5-crown-5 prepared by vaporising caesium metal over 15-crown-5, is incorporated within the polymer composition. Other ionophore, zeolite and ion exchange materials might be similarly employed. Such a composition has a low electron work function, typically <<1 electron-volt, such that low DC or non-uniform AC voltages switch it from insulative to conductive phase with decreasing time constant and increasing the bandwidth for adsorbed species and of the system. Such materials may be used to detect the presence of adsorbed materials and or radiation sources.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred forms of the invention are described more fully with reference to the accompanying drawings, in which:

FIG. **1** is an exploded view of a variable resistor shaving a flexible or rigid external connecting means;

FIG. **2** shows three variants of the element shown in FIG. **1**;

FIG. **3** shows two variable resistors having a configuration of element and external connections different from those of FIGS. **1** and **2**; these optionally use connectors according a second aspect of the invention; and

FIG. **4** shows exploded views of two multi-function variable resistors.

Any of the variable resistors shown in the drawings may form the basis of a sensor according to a third aspect of the invention.

DETAILED DESCRIPTION OF THE INVENTION

EXAMPLE

An example of a conductive foam structure for the element is as follows: a polyether open-cell foam sheet 2