

the path of electrons through the polymer coating on the filler particles and thus decreases quantum tunnelling conductance.

In aspect (c) the effect of the mechanically coupled workpiece is to compress the polymer composition, thus decreasing the separation between filler particles, shortening the electron path and increasing tunnelling conductance. The workpiece may act as a mechanical member, for example a piston or lever; instead or in addition it may be act randomly, for example as particles mixed with particles of the polymer composition. Evidently the operation of aspect (c) can oppose the operation of (a) or (b); this is, however, applicable in specialised conditions.

Each sensor includes means for ohmic connection of the polymer composition to an electrical circuit. To match the very long curve of conductance versus applied stress, the circuit preferably includes field-effect-transistors and logarithmic amplification. To distinguish analytes by rate of change of conductance, differential circuitry may be used. Ohmic connection can be conveniently provided by enclosing a permeable block of polymer composition between grids wholly or partly of ohmic conductive material, for example metal, or light metal mesh backed by plastic or ceramic, or metallised ceramic. If the polymer composition is in sheet form stretched across the channel, spaced ohmic conductors may be for example mechanically held in contact with it or formed on it as a coating such as a metal-rich paint or vapour-deposited layer. Intermediate and/or external conductors, ohmic or not, may comprise a pre-stressed polymer composition, possibly on a polymer or textile support.

Each sensor according to aspect (a) or (b) further includes means to stress the polymer composition to an initial level of electrical conductance susceptible to measurable change as a result of contact with the test fluid. This is conveniently provided by compressing the body by disposing the body in a tube between grids and squeezing the grids together, suitably by the action of an internal sleeve slidable telescope-wise in the tube, possibly using a micrometer. For sheet form composition stressing is suitably by stretching by a sock-donning action or by bending unsupported or supported e.g. over a former or by deforming a disc to a shallow cone or spheroid.

For each the polymer composition may be stressed before contacting. This may be effected for example by suitable formulation of the composition such as mixing in presence of a volatile liquid removal of which compresses the composition to conductance. In another method its stress/resistance response may be measured after contacting and compared with a standard, typically the same or a duplicate head in equilibrium with blank fluid. Mechanical means of pre-stressing may be for example screw, hydraulic, piezo-electric, magnetic and thermal expansion e.g. using a bimorph.

A preferred composition is in the form of particles coated with polymer. The coating may be shrunk-on, possibly with compression sufficient for pre-stress to conduction. The particles may be for example granules as described herein, agglomerates thereof or comminuted bulk composition. The coating is permeable to analytes to which the sensor is to be applied. It is also thin enough to permit electrical conduction by quantum tunnelling as described below or, possibly at greater thickness, by conductive filler such as in the composition and/or carbon. The shrunk-on polymer is suitably a thermoset, for example epoxy, maleimide or 3-dimensional olefin resin.

The pre-stressed particles may be used in a loose-packed bed as in FIG. 1(a), 3(c) or 4(d) below. Conveniently they may adhere together, possibly with mild compression, in a

shaped unit as in FIG. 7 below. Thus a series of units may be set up, differing in analyte response but interchangeable in the sensor structure.

For aspect (c) the option is available to start at non-conductance or 'start-resistance' as an alternative to initial stressing to conductance, and use the swelling of the polymer element to produce or increase conductance in the polymer composition.

Instead of or in addition, each sensor may be brought to the first level of conductance by an applied voltage and/or an electrostatic or radiative or magnetic field. The first level of conductance of the polymer composition is preferably substantially zero or at a low value ('start-resistance') sufficient to indicate that the sensor is in circuit.

The sensor may be used in combination with external means to modify its response. For example the fluid may be contacted, upstream of the head, with a sorbent effective to remove one trace material, leaving another to be determined by the sensor. In a particular embodiment the sorbent may be disposed close to the sensor head, thus avoiding a separate treatment step. Conversely a sorptive source of co-determinable material may be used. Drying and (respectively) humidification are examples.

In another example, suitable for very low concentrations of trace material, such a sorbent may be used to take up and store the whole amount of such material over a time period, then heated to desorb the material and pass it to the sensor.

Combination set-ups used in analysis may include, for example:

- means to inject a known content of a known trace material, e.g. for calibration or co-sorption;
- two sensors in parallel, one calibrated as reference;
- an array of two or more sensors in series or parallel, for simultaneous detection of different trace materials;
- a series succession of separately wired sensors constituting a chromatographic column;
- supply of blank fluid, with changeover switching, to regenerate the sensor;
- local heating to change specificity or assist regeneration; for this purpose the polymer composition or swellable polymer or sorbent may contain a heating coil or the polymer composition may be heated by feeding electricity to it up to its PTC temperature;
- a substantial number of devices in parallel, with fluid changeover switching, to afford longer time for regeneration if required;
- miniaturisation;
- feedback control of stress levels;
- computerised recording, comparing, transmitting.

Swellable polymers in aspect (c) and sorbents used to modify the response of the sensor may be selected from for example:

Structure-Wise:

- compressed, sintered or bonded particulate;
- coatings on high-surface support such as honeycomb or foam or textile;
- ion-exchange resins;
- chromatographic agents;

Chemical Composition:

chosen according to solubility parameter or chemical reactivity, for example for hydrocarbons, oxygenated hydrocarbons, acidics, basics, water, viruses, bacteria.

Any of the sensors may of course be used to determine the presence of an analyte or register the absence of an analyte that ought to be present.