CARBON DIOXIDE SENSOR

AGENȚIA DE STAT PENTRU PROPRIETATEA INTELECTUALĂ A REPUBLICII MOLDOVA

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INTRODUCTION

- Carbon dioxide (CO_2) detection is important in various sectors of domestic and industrial activity, such as indoor air quality control (air conditioning and ventilation systems), healthcare (monitoring of respiration, anaesthesia), agriculture (monitoring of CO_2 flow in soil), food technology (packaging processes, transport), alcoholic beverage industry.
- Along with optical, electrochemical and resistive sensors, gravimetric sensors are a solution for CO_2 monitoring.
- Drawback: Non-dispersive infrared (NDIR) structures, the most commonly used commercial devices used for CO_2 monitoring, have disadvantages, such as high cost, spectral interference and high detection limit.

ORIGINAL APPROACH

The invention includes the design and manufacturing processes for a surface acoustic wave (SAW) CO_2 sensor, employing carbon nanohorns and carbon nanoonions functionalized with groups such as -CO-NH-CH_2-CH_2-NH-CH_2-CH_2-NH_2, (abbreviated as CNHs-R-NH-R-NH_2 and CNOs-R-NH-R-NH2, Fig.1 and Fig.2) as sensing layer, a quartz piezoelectric substrate and interdigital transducers. This type of functionalization ensures appropiate selectivity to the nanocarbonic materials by grafting aliphatic primary and secondary amine groups. Aliphatic amines, according to the HSAB theory, are hard bases and can interact reversibly, at room temperature with CO_2 (hard acid) to form carbamates. The sensing structure used is of the "delay line" type, having a double delay line in order to compensate the thermal drift. One of the delay lines is coated with CNOs-R-NH-R-NH_2, the second delay line being the piezoelectric substrate without a sensitive layer. To obtain a signal due exclusively to the chemical interaction between CNOs-R-NH-R-NH_2 and CO_2, the signal associated with the second delay line can be subtracted from the signal of the first delay line (Fig.3)

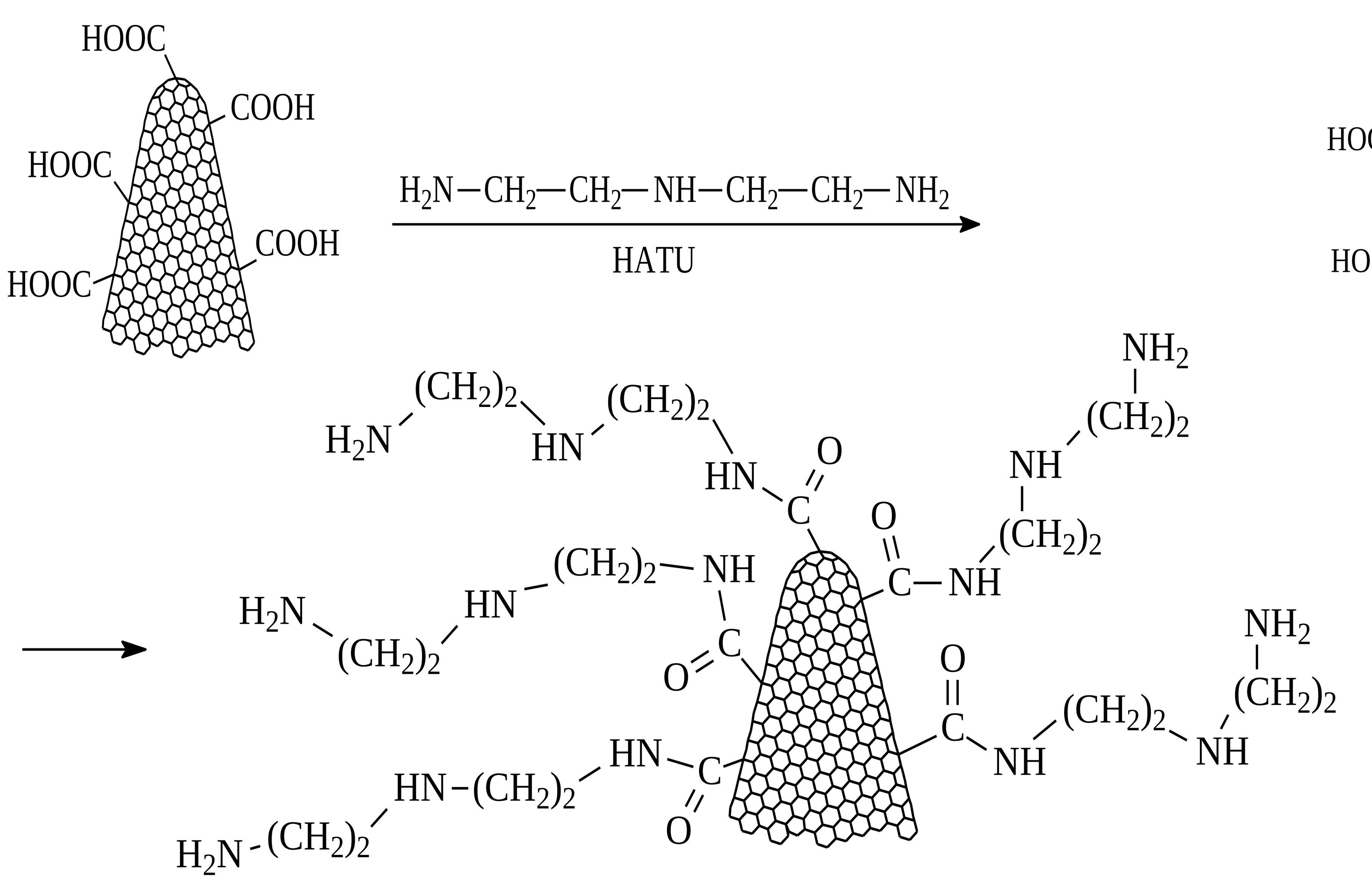

Fig. 1 Structure of CNHs-R-NH-R-NH_2

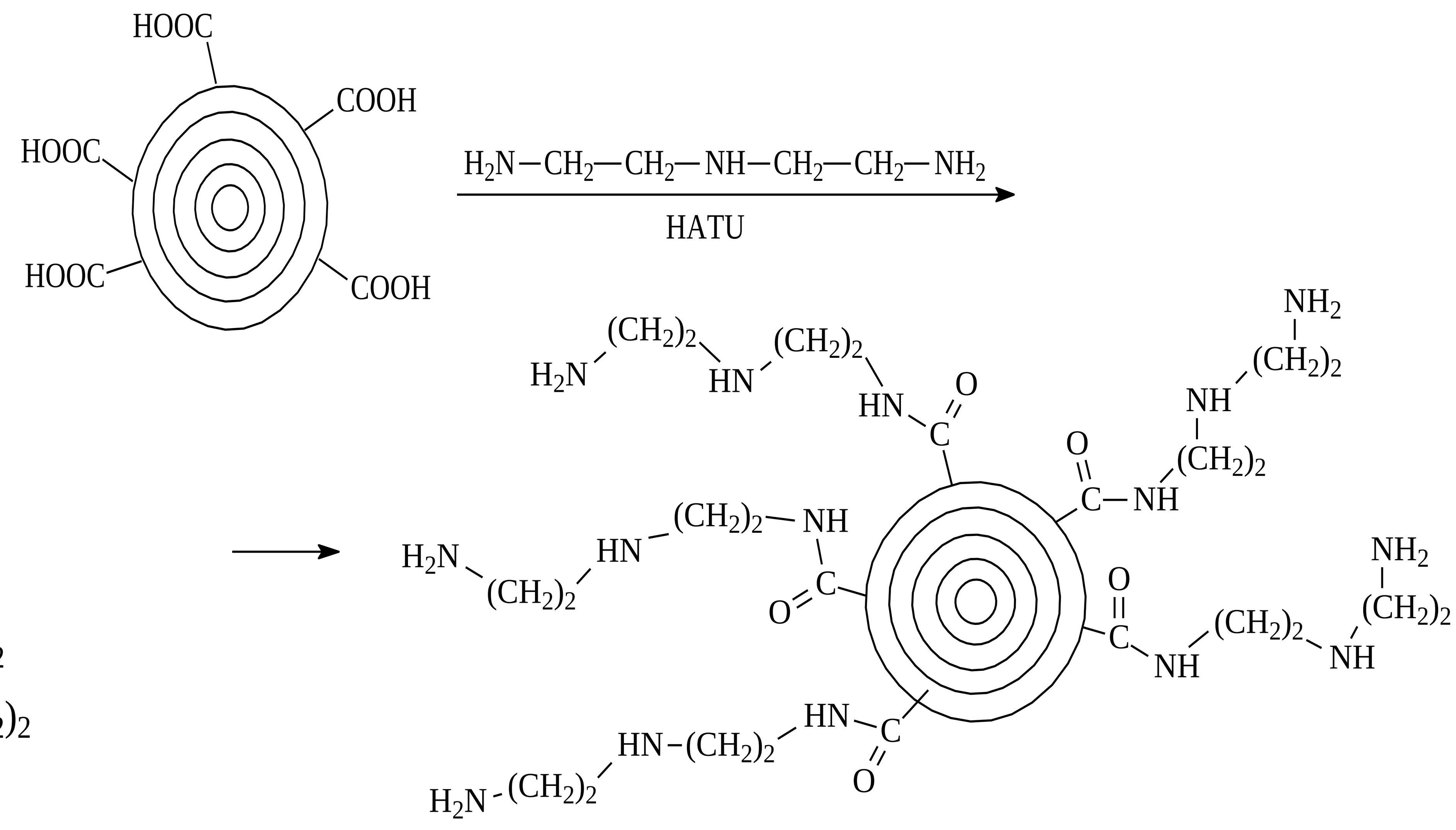

Fig. 2 Structure of CNOs-R-NH-R-NH_2

SYNTHESIS OF THE SENSING LAYER

- Oxidized carbon nanoborns (10 mg), purchased from Sigma Aldrich, and 1 mL of (*N*-[(dimetilamino)-1*H*-1,2,3-triazolo[4,5,6]piridin-1-ylmetilen]-*N*-metillmetanaminium hexafluorofosfat *N*-oxide- HATU)are dispersed in 5 mL diethylenetriamine and subjected to ultra sonication for 3 hours.
- The reaction mixture was diluted with 100 mL methanol and then filtered.
- The solid product is dried in the oven at 100 ^{o}C for 1 hour, under vacuum.
- A solution of CNHs-R-NH-R-NH_2 (5 mg) in 50 mL dimethylformamide is ultrasonicated at RT for 10 hours.
- The obtained solution is deposited by the spin coating method on the quartz substrate (3000 rpm, for 60 s).
- The film is heated to 100 ^{o}C for 90 mins. The obtained film is subject to a final heat treatment, at 100 ^{o}C, for 60 mins.

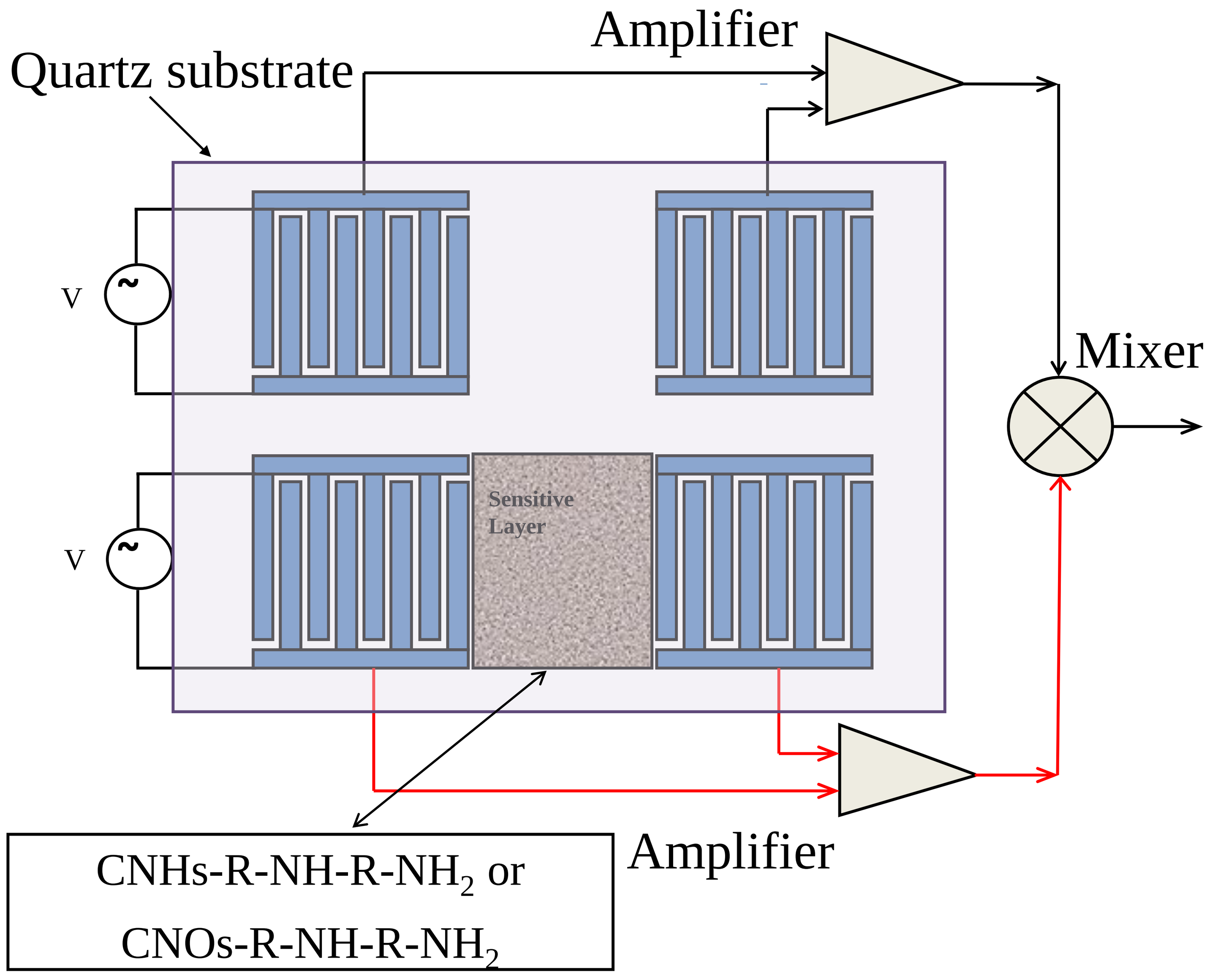

Fig. 3 The sensing structure

ADVANTAGES OF THE PROPOSED SENSING LAYERS

- Improved mechanical properties, better processability, fast response, detection at RT, fast response, increased selectivity;
- High specific area / volume ratio, affinity for CO_2 molecules through HSAB-type interactions ("mass loading"), as well as a variation of its resistance in contact with CO_2 molecules ("electric loading").