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Simple graphene based multisensor array for gas analysis

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OBJECTIVE

We have developed the fabrication protocols and tested the performance of multisensor arrays based on single graphene sheet operating at room temperature. The first prototypes have been tested against ethanol, isopropanol and methanol vapors mixed with synthetic air to address the healthcare issue of detection of methanol traces in the food and beverages. The vector signal of the multisensor array has been processed by artificial neural network (ANN) trained under back-propagation Levenberg-Marquardt algorithm and showed successful gas recognition
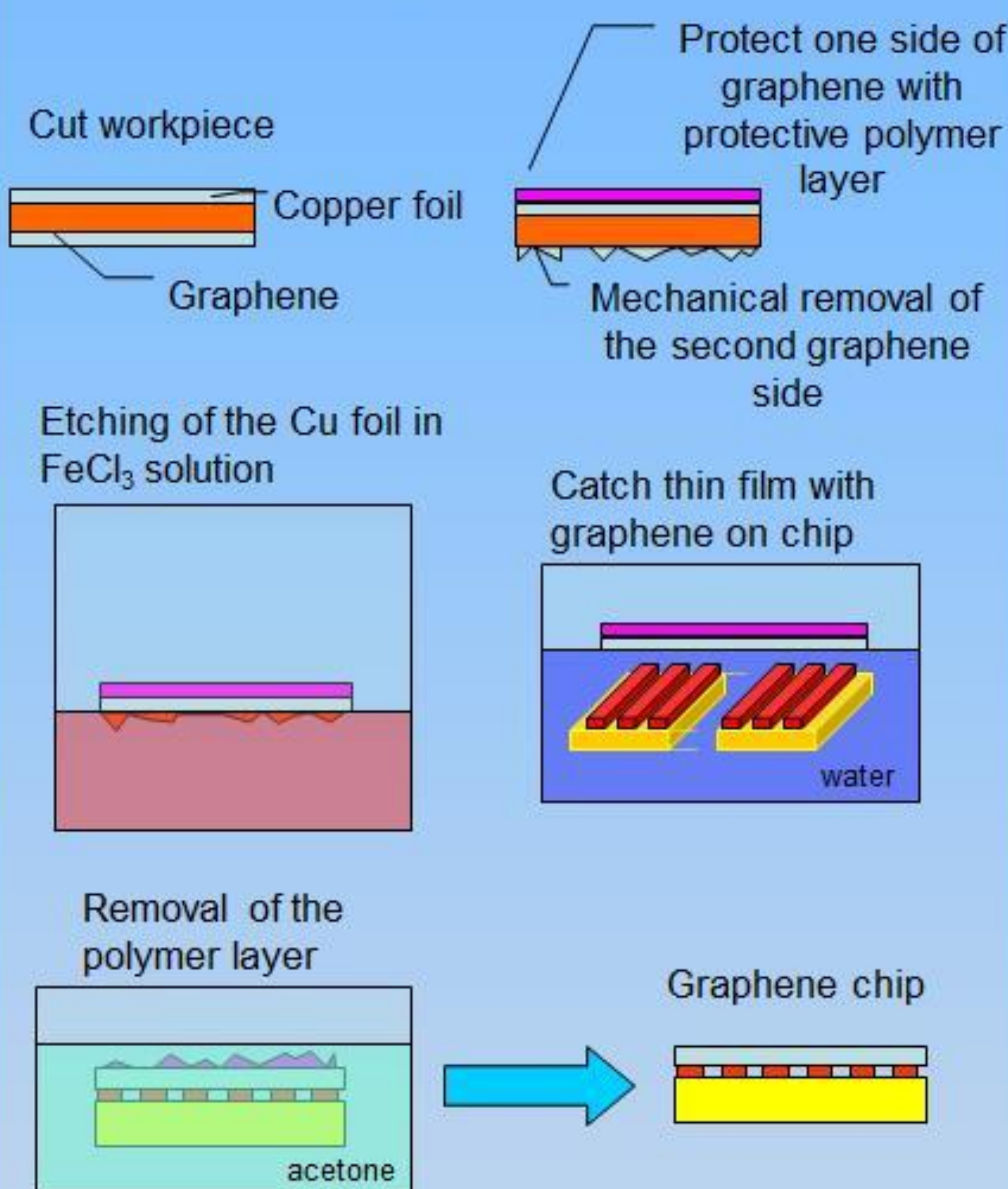
GRAPHENE-BASED MICROARRAY FABRICATION.

Cut workpiece
Copper foil
Graphene

Protect one side of graphene with protective polymer layer

Mechanical removal of the second graphene side

Etching of the Cu foil in FeCl$_3$ solution

Catch thin film with graphene on chip
water

Removal of the polymer layer
acetone

Graphene chip

Fig. 1: *The general scheme of graphene based chip fabrication*
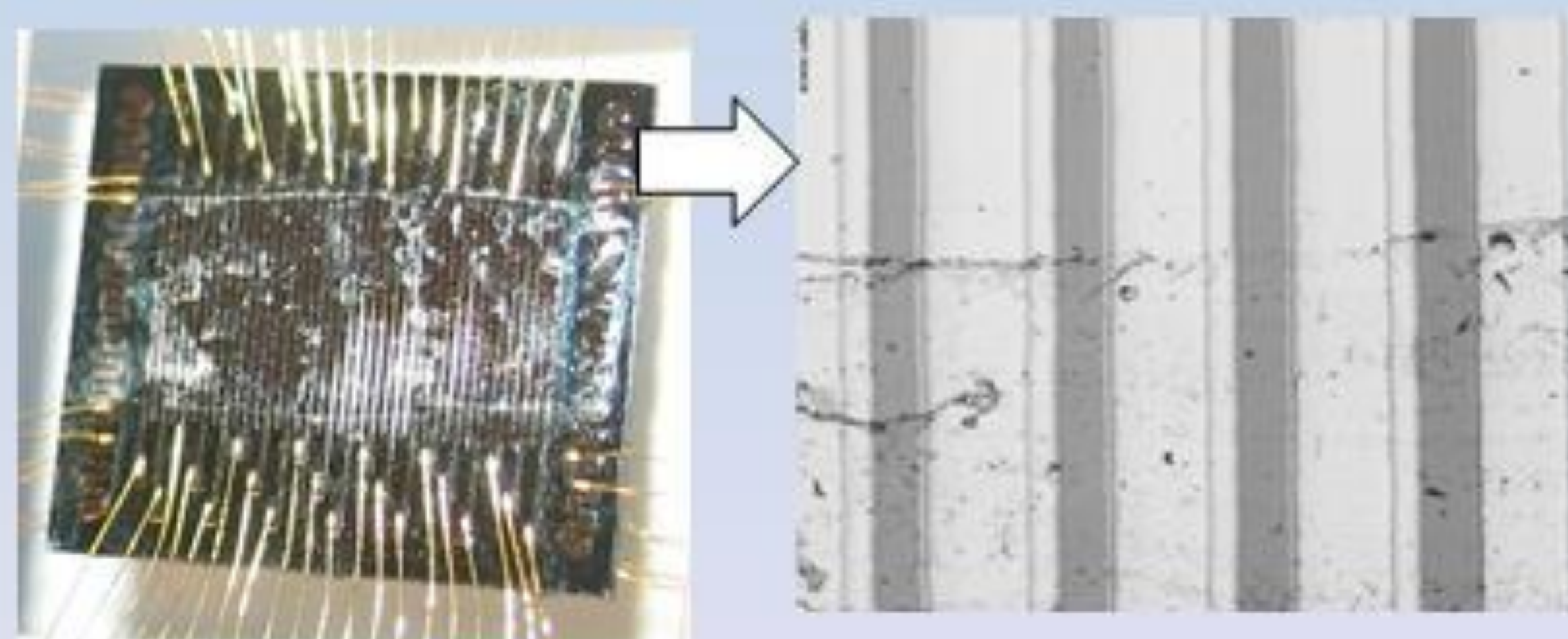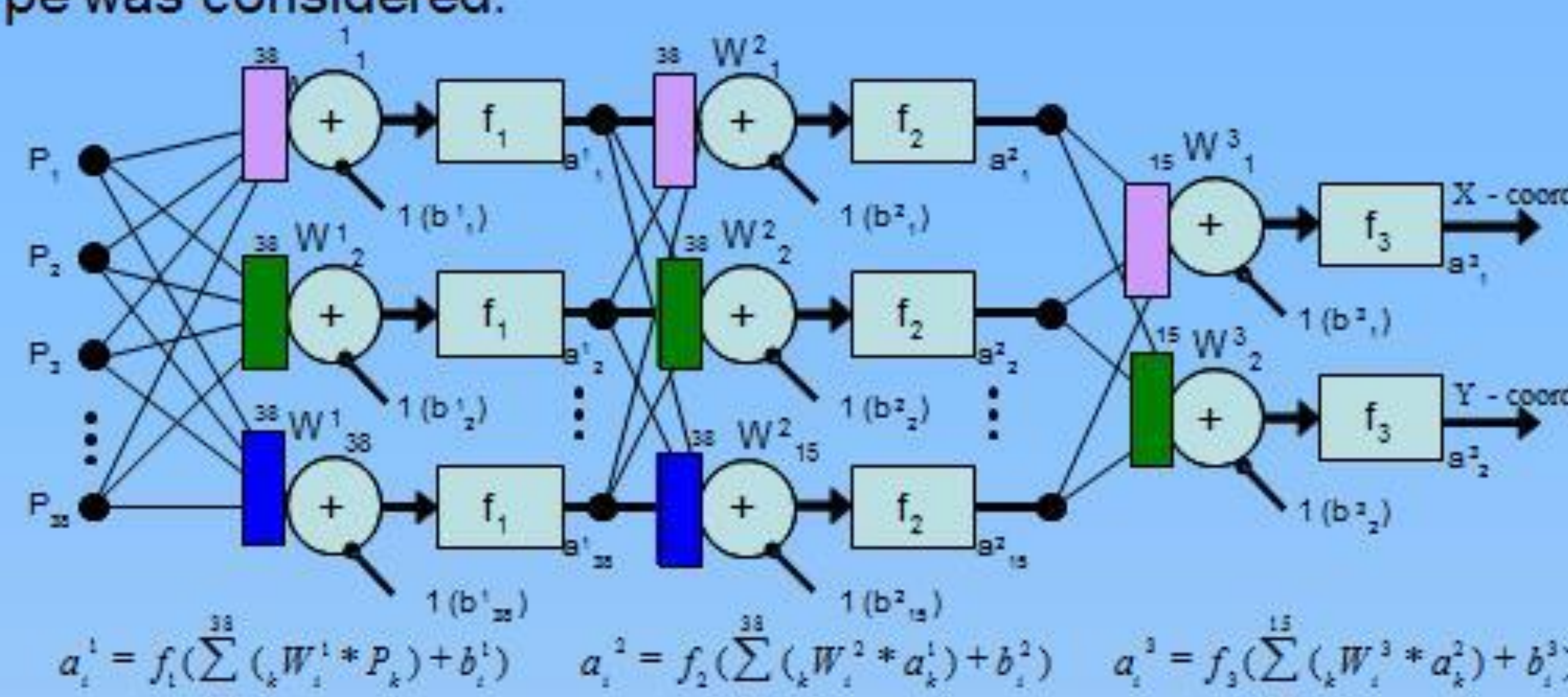
GRAPHENE-BASED MULTISENSOR CHIP

Fig. 2: *The fabricated chip prototype and measured distribution of graphene segment resistance over the array*

PATTERN RECOGNITION TECHNIQUES

The ANNs of following type was considered:

2. The multi-layer perceptron (MLP):

Three neuron layers (38/15/2);
Activation functions:
"logsig" (sigmoid),
"logsig" (sigmoid),
"purelin" (linear).

$$a_i^1 = f_1(\sum_{k=1}^{38}(_kW_i^1 * P_k) + b_i^1) \qquad a_i^2 = f_2(\sum_{k=1}^{38}(_kW_i^2 * a_k^1) + b_i^2) \qquad a_i^3 = f_3(\sum_{k=1}^{15}(_kW_i^3 * a_k^2) + b_i^3)$$
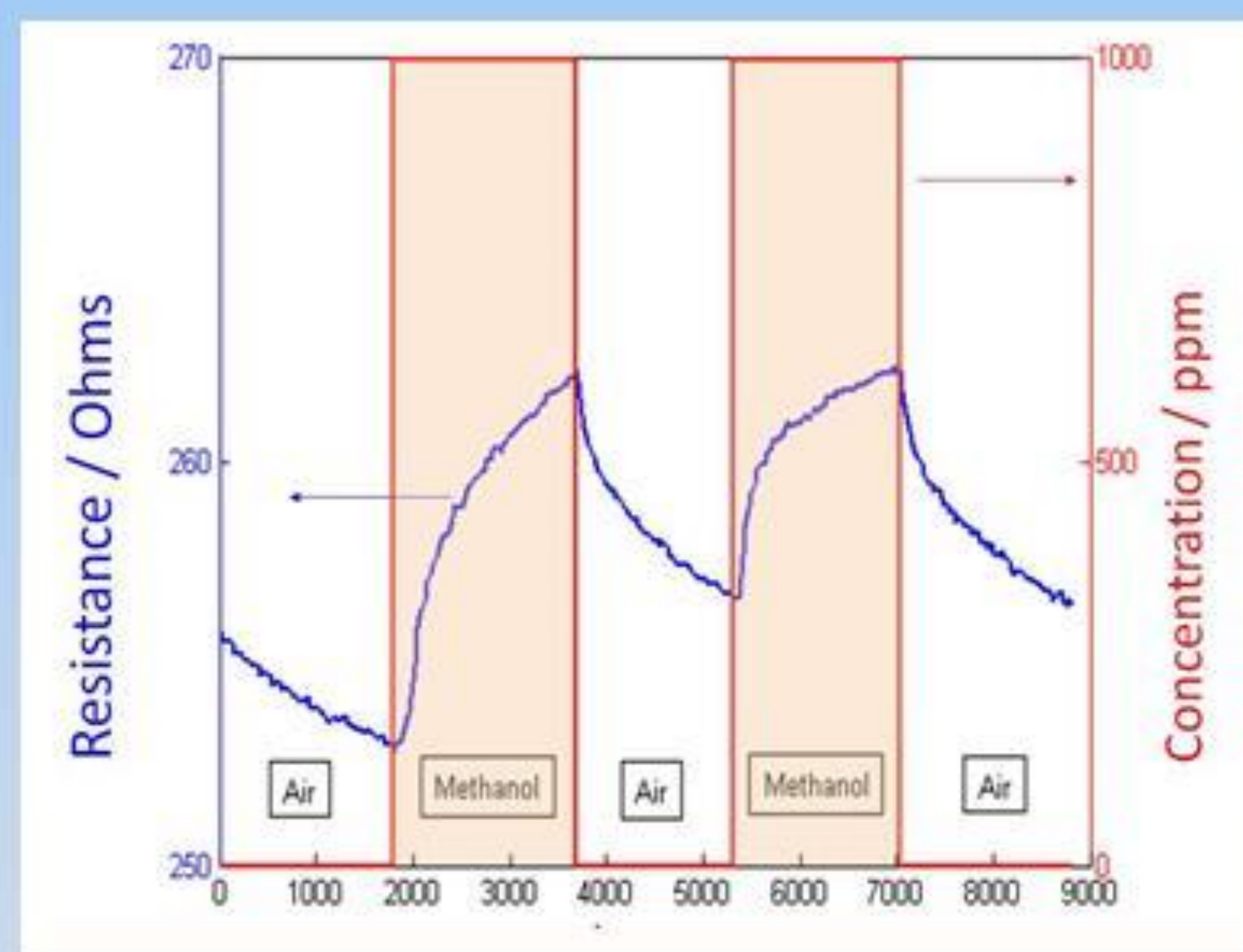
RESULTS

Fig.3: *The response of the graphene - based multisensor array to the mixtures of methanol with a synthetic air as a change of resistance of the median sensor segment versus time of exposure to the gas*
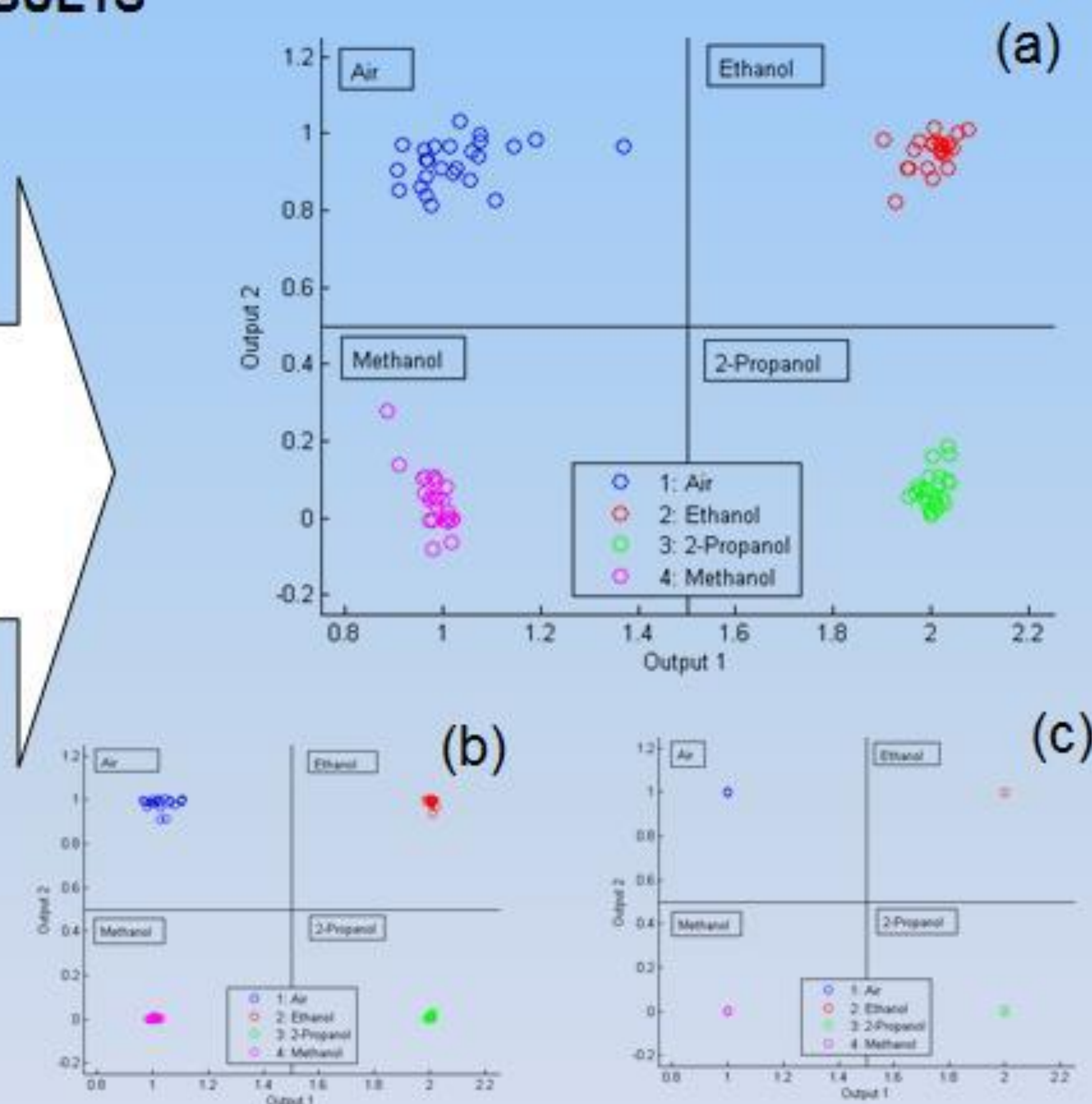
Fig.4: *The results of processing the response on graphene – based multisensor array to sample reducing gases and air by 3-layer perceptron ANN: a) under XXX error; b) under XXX error; c) under XXX error*

CONCLUSIONS

A simple protocol for fabrication of the graphene based sensing array has been tested. The device prototype demonstrated a promising performance at room temperature. The optimizations of the graphene layer dimensions are necessary to increase the sensitivity and miniaturize the array.

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