The 5th International Electronic Conference on Applied Sciences

ASEC 2024 Conference

04–06 December 2024 | Online

Quest for piezoresistive strain sensors based on polymer nanocomposites for human motion monitoring

Antonio del Bosque*[1,2], Xoan F. Sánchez Romate[2], María Sánchez[2], Alejandro Ureña[2]

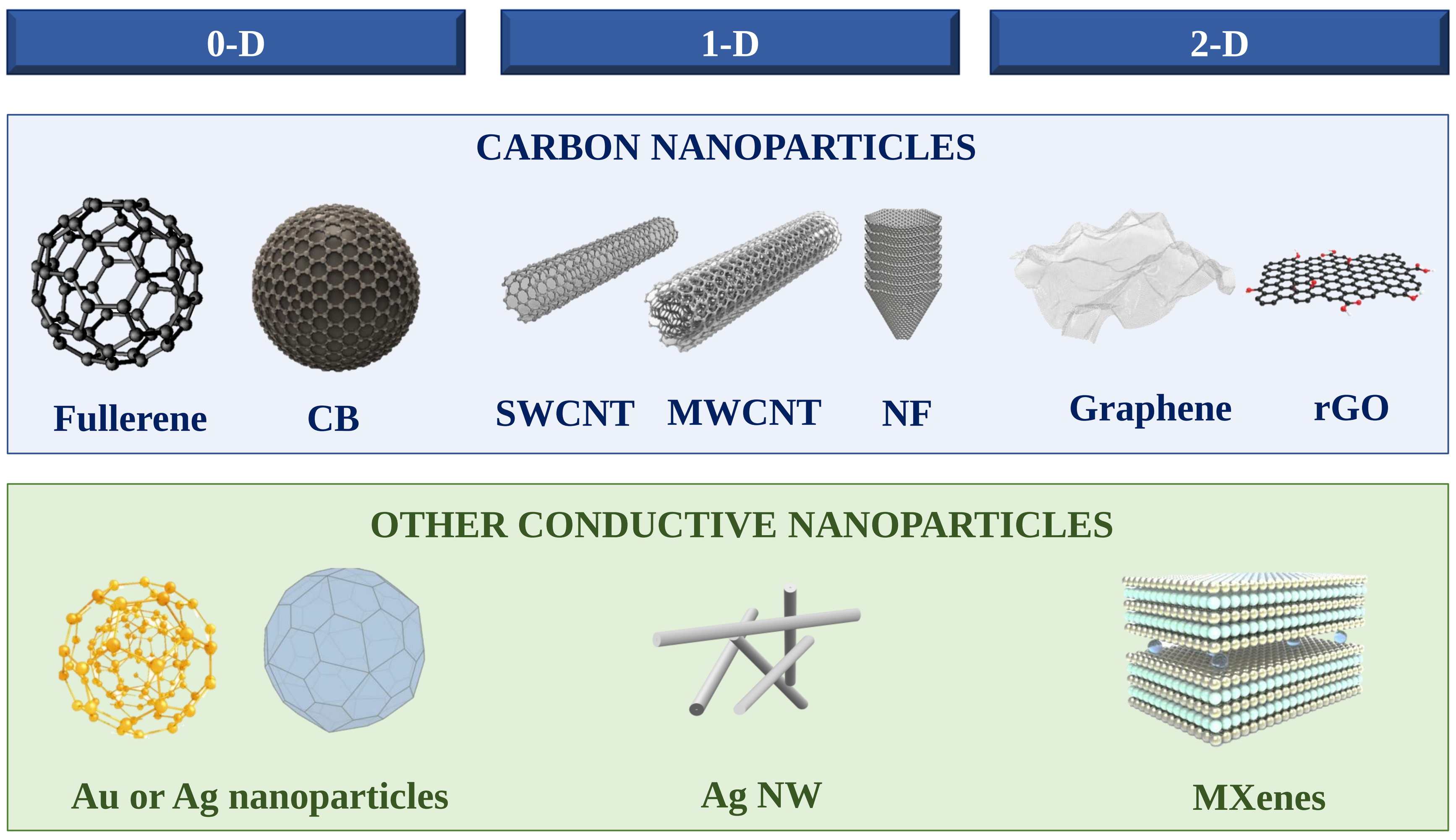
[1] Technology, Instruction and Design in Engineering and Education Research Group (TiDEE.rg), Catholic University of Ávila, C/Canteros s/n, E-05005 Ávila, Spain

[2] Materials Science and Engineering Area, Escuela Superior de Ciencias Experimentales y Tecnología, Universidad Rey Juan Carlos, C/Tulipán s/n, 28933, Móstoles, Spain

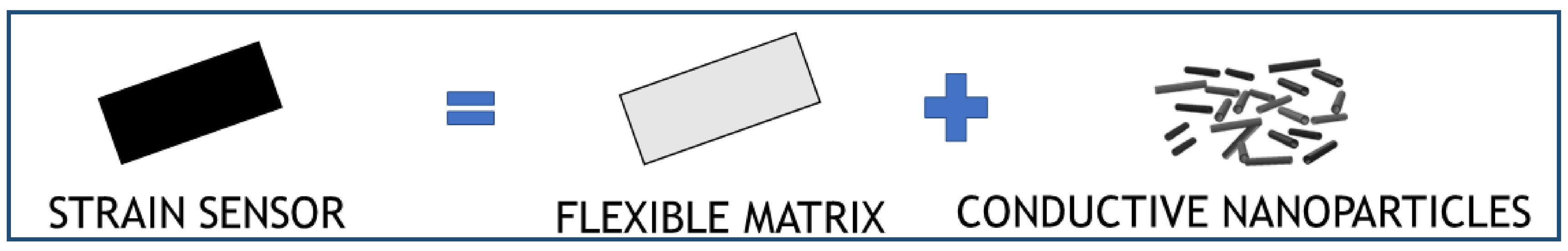
Correspondence: antonio.bosque@ucavila.es

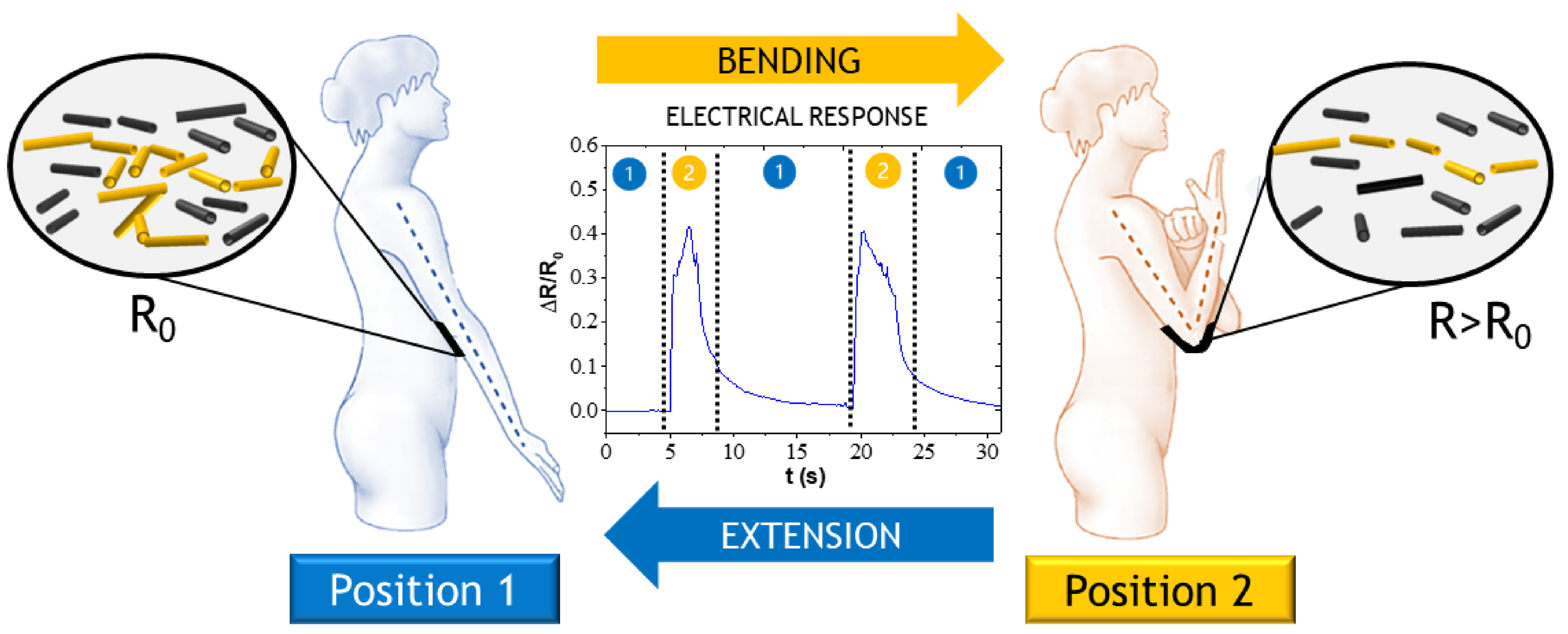
INTRODUCTION & AIM

The addition of conductive nanoparticles to a flexible polymer matrix has a very relevant effect on the properties of the final composite material. For example, the electrical, mechanical, thermal, magnetic and optical properties are greatly affected depending on the type of matrix and nanoreinforcement selected, as well as the dispersion and manufacturing method used. Conductive nanoparticles can be classified according to their nature or regarding to their characteristic dimensions (0D, 1D, 2D).



it is possible to monitor the strain of the material from the measurement of its electrical resistance for a wide range of applications, such as the monitoring of human movements. Additionally, the presence of damage (fractures, cracks, etc.) in the material can also be detected, since its formation or propagation causes an increase in the electrical resistance since the presence of this type of discontinuities induces the rupture of the conductive network generated by the nanoreinforcement.

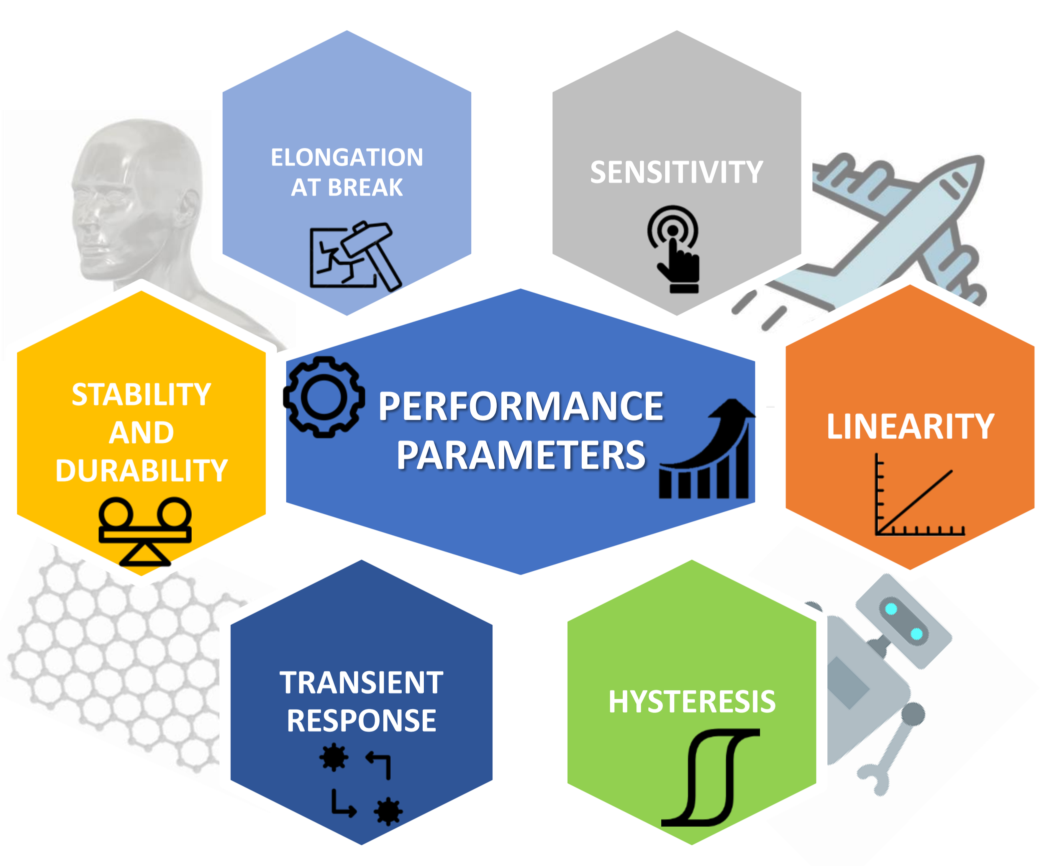




PERFORMANCE PARAMETERS

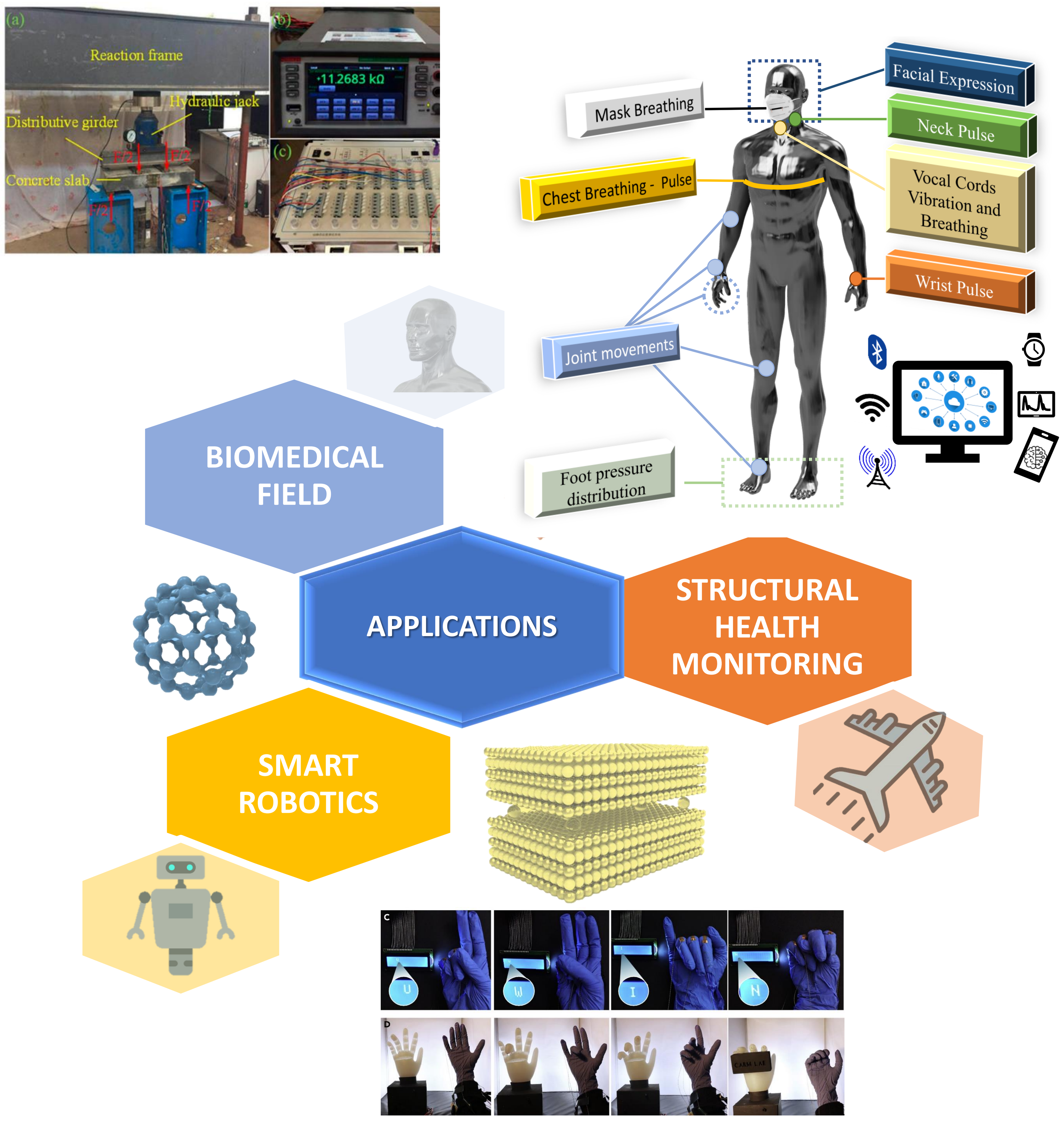
The evaluation of the properties or performance parameters of strain sensors is very important depending on the final application. The elongation at break, sensitivity, linearity, hysteresis, transient response, stability and durability are identified.

Strain sensors can be exposed to different environmental conditions throughout their lifetime (humidity, temperature, acidity or alkalinity levels), depending on the final application. This makes it relevant to study its impact on the performance parameter.



APPLICATIONS

sensors can be implemented for biomedical applications for the measurement of small or large strain level promoted by human movements such as breathing or the movements of the joints of the body, respectively. In addition, these signals can be used for virtual reality and robotics. Finally, these types of sensors are also valid for structural health monitoring that allows to know in real time the state of a structure, that is, its physical integrity.



LIMITATIONS AND TRENDS

Flexible piezoresistive sensors hold promise for addressing future technological challenges, particularly in remote health monitoring. However, to make them viable for practical use, several issues need to be addressed. These include improving sensor performance (e.g., maximizing sensitivity, stability, and durability), ensuring biocompatibility, studying environmental impacts on sensor functionality, and incorporating additional features like self-repair. Additionally, there is a need for scalable manufacturing methods using commercially available materials, integrating sensors with power supply and data management systems, enabling real-time remote signal transmission, and applying AI tools to optimize sensor data. Finally, accurate analytical models must be developed to predict sensor performance over time.

CONCLUSIONS

In recent decades, the advance of nanotechnology has directly influenced the development of biomedical, aerospace, sports and automotive applications. The share of the flexible electronics market will increase exponentially in the coming decades. Firstly, this is because it has been estimated that more than 23% of the population will reach 65 years old by 2035, so low-cost and easily accessible medical facilities will be needed to control various health-related problems. In addition, all this is encompassed in several sustainable development goals (SDGs), such as improving health and well-being (SDG 3), industry, innovation in infrastructure (SDG 9), as well as the improvement of sustainable cities and communities (SDG 11).

ACKNOWLEDGEMENTS

This research was funded by the Agencia Estatal de Investigación of Spanish Government (Project MULTISENS PID2022-136636OB-I00) and Young Researchers IMPULSO program by Universidad Rey Juan Carlos [ref. 2986, SMARTSENS].