Smart materials and their role in modern chemical engineering.

Micaela Tosi*

Department of Biotechnology, University of Berne, Switzerland

Smart materials, also known as responsive materials, possess properties that can be dynamically altered in response to changes in their environment. In the realm of chemical engineering, these materials play a pivotal role in revolutionizing processes, enhancing efficiency, and enabling novel applications. Smart materials encompass a wide range of substances with unique properties that can be manipulated in a controlled manner. These materials exhibit responsiveness to external stimuli such as temperature, pH, light, electric or magnetic fields, mechanical stress, and chemical composition. Examples include shape memory alloys, hydrogels, piezoelectric materials, and stimuli-responsive polymers [1, 2].

Smart materials enable process intensification by facilitating precise control over reaction conditions. For instance, stimuli-responsive catalysts can adjust their activity based on changes in temperature or reactant concentrations, leading to improved selectivity and yield in chemical reactions [3].

Smart materials serve as sensing elements in chemical engineering applications, providing real-time monitoring of process parameters. Functionalized nanomaterials can detect minute changes in environmental conditions, facilitating early detection of contaminants, leaks, or deviations from optimal operating conditions. In pharmaceutical manufacturing, smart materials are employed to design advanced drug delivery systems with controlled release properties. Stimuli-responsive nanoparticles can release therapeutic agents at specific sites within the body, enhancing drug efficacy while minimizing side effects [4, 5].

Smart membranes exhibit tunable permeability in response to external stimuli, enabling precise separation of components in chemical processes. By adjusting pore size or surface chemistry in real-time, these membranes enhance efficiency and reduce energy consumption in separation processes. The integration of smart materials allows for the development of adaptive equipment and devices in chemical engineering. For example, self-healing coatings can repair damage to equipment surfaces, extending their lifespan and reducing maintenance costs [6].

While smart materials offer exciting opportunities in modern chemical engineering, several challenges must be addressed to realize their full potential. These include scalability and cost-effectiveness of production, long-term stability and reliability, as well as compatibility with existing industrial processes and regulations. Continued research and interdisciplinary collaboration will be essential to overcome these hurdles and unlock new possibilities in the field [7].

Smart materials represent a paradigm shift in modern chemical engineering, offering unprecedented levels of control, adaptability, and functionality. From enhancing process efficiency to enabling innovative applications in drug delivery and sensing, these materials are poised to drive significant advancements in the field. As research and development efforts continue, smart materials hold the promise of reshaping the landscape of chemical engineering and contributing to a more sustainable and technologically advanced future [8- 10].

References

1. Carole TM, Pellegrino J, Paster MD. Opportunities in the industrial biobased products industry. In Proceedings of the Twenty-Fifth Symposium on Biotechnology for Fuels and Chemicals.2003, Breckenridge, CO 2004.Humana Press. Appl Biochem Biotechnol.2004 Spring;113-116:871-85.
2. Erickson B, Nelson, Winters P. Perspective on opportunities in industrial biotechnology in renewable chemicals. J Biotechnol. 2012;7(2):176-85.
3. Hermann BG, Blok K, Patel MK. Producing bio-based bulk chemicals using industrial biotechnology saves energy and combats climate change. Environ Sci Technol.2007;41(22):7915-21.
4. Dornburg V, Hermann BG, Patel MK. Scenario projections for future market potentials of biobased bulk chemicals. Environ Sci Technol.2008;42(7):2261-7.
5. Xu Y, Isom L, Hanna MA. Adding value to carbon dioxide from ethanol fermentations. Bioresour Technol. 2010;101(10):3311-9.
6. Johnson IS. The trials and tribulations of producing the first genetically engineered drug. Nat Rev Drug Discov. 2003;2(9):747-51.
7. Peng Z. Current status of gendicine in China: recombinant human Ad-p53 agent for treatment of cancers. Human Gene Therapy. 2005;16(9):1016-27.
8. Chen S, Yu L, Jiang C, et al. Pivotal study of iodine-131–labeled chimeric tumor necrosis treatment radioimmunotherapy in patients with advanced lung cancer. J Clin Oncol.2005;23(7):1538-47.

***Correspondence to:** Micaela Tosi, Department of Biotechnology, University of Berne, Switzerland. E-mail: micaelatosi@gmail.com

***Received:** 08-Feb-2024, Manuscript No. AAAIB-24-135802; **Editor assigned:** 12-Feb-2024, PreQC No. AAAIB-24-135802 (PQ); **Reviewed:** 20-Feb-2024, QC No. AAAIB-24-135802; **Revised:** 24-Feb-2024, Manuscript No. AAAIB-24-135802 (R); **Published:** 27-Feb-2024, DOI: 10.35841/aaaib- 8.1.191*

***Citation:** Tosi M. Smart materials and their role in modern chemical engineering. Arch Ind Biot. 2024; 8(1):191*

9. Crombet T, Osorio M, Cruz T, et al. Use of the humanized anti-epidermal growth factor receptor monoclonal antibody h-R3 in combination with radiotherapy in the treatment of locally advanced head and neck cancer patients. J Clin Oncol. 2004;22(9):1646-54.

10. Bao GQ, Li Y, Ma QJ, et al. Isolating human antibody against human hepatocellular carcinoma by guided-selection. Cancer Biol 2005;4(12):1374-80.

Citation: *Tosi M. Smart materials and their role in modern chemical engineering. Arch Ind Biot. 2024; 8(1):191*