開發用具有原子尺度共伴化學效應觸媒並用於氫氣儲存/轉化以及氣凝膠細胞損傷修補

Atomic synergetic collaboration catalysts for H_2 storage and evolution toward H_2 aerosol technique in biomedical therapy

Chi-Shuo Chen[1], Ho-Hsiu Chou[2], Chien-Chun Chen[3], Tiffany Hsin-Yi Chen[3], Yu-Jui (Ray) Fan[4] and Tsan-Yao Chen[3*]

[1]Department of Biomedical Engineering and Environmental Science, National Tsing Hau University, Hsinchu 30013, Taiwan

[2]Department of Chemical Engineering, National Tsing Hua University, Hsinchu 30013, Taiwan

[3]Department of Engineering and System Science, National Tsing Hua University, Hsinchu 30013, Taiwan

[4]School of Biomedical Engineering, Taipei Medical University, Taipei 11031, Taiwan

E-mail: chencaeser@gmail.com

We anticipate to develop a microfluidic system combining nanocatalyst (NCs) and carbon nanosphere (CNS) the direct photocatalytic H_2 production and the slow release of H_2 to the cancel cell treatment. The ROS is an important biophysical signature for the control and the manipulating the function for most types of components in the cancel cells. By interacting with the H_2 molecules, the chemical characteristic of ROS will be changed so that the bio-activity of the cancel cell will be suppressed. With these understandings, based on the physical characteristics of existing materials in our team, two H_2 slow release technologies are proposed for the development of implant medical applications including the hybrid composites of organic-inorganic semiconductor photocatalytic catalysts and the H_2 storage CNS. In the practical scenarios, the former will be sealed in a transparent membrane capsule and the later will be filled with H_2 prior to their deployment in the treating organs. To virtualize the proposed concept, the validation of the conceptual prototype design including the functional test, the process optimization and theoretical materials calculation prediction. Topics include the photocatalytic H_2 production yield on the hybrid composites, the HER performance of the atomic catalysts, the H_2 storage capacity of the CNS as well as the subsequent biomedical responses. The correlation between

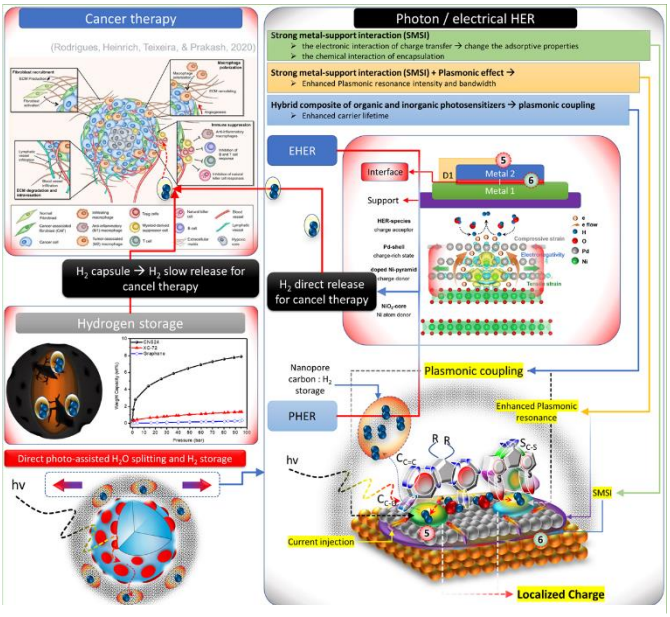

Figure 1 Correlation between CNS, hybrid composites of organic/inoranic semiconductor catslysts and the H_2 treating on cancer therapy

the aforementioned research topics are shown in Figure 1 and the corresponding results are summarized later.

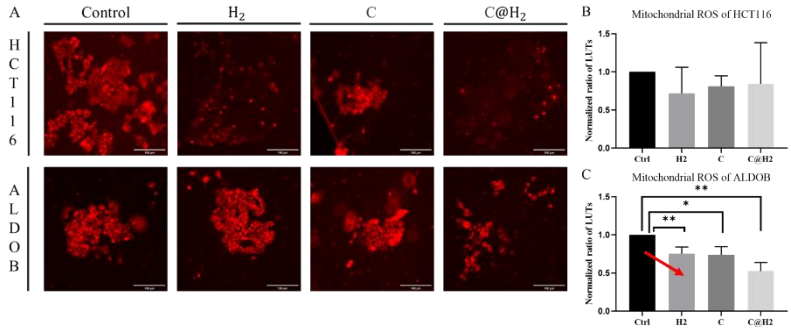

Figure 2 HCT116 and ALDOB cell degradation test results.

In cancer cell treatment, the MitoSOX test reveals that a low level of H_2 ~3ppm reduces the $\cdot O^{2-}$ radical concentration by 70% and influences the cell degradation mechanism. In addition, the combination of H_2 and 5-FU further degrades the cell by 38% thus showing possibility of such a protocol in the cancer therapy. Slow release of H_2 without outer interference is a key factor in the long-term treatment. Our results indicate that with the insertion of H_2 filled CNS the cell degradation can be further increased by 50% as compared to the H_2 and 5-FU control (Figure 2).

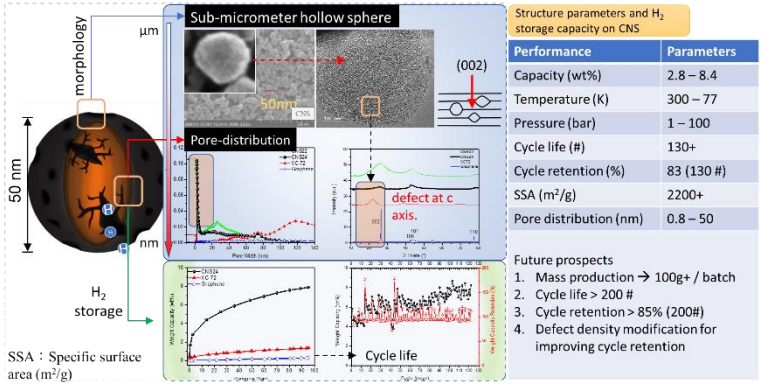

Figure 3 The physical structure parameters and the H_2 storage capacity of CNS.

The H_2 storage capacity, cycle life and the corresponding physical structures of CNS are shown in **Figure 3**. Accordingly, the H_2 capacity is 2.6 and 8.1 wt% respectively at 77K and 300K at 100 bars. These features are dominated by the defect density, the pore ratio, pore distribution and the specific surface area of the carbon material. Our results show that the proposed CNS possesses the equilibrium physical structure parameters to the state-of-the-art carbon materials with highest H_2 storage capacity. Results of the corresponding topics are summarized in **Table 1.**

Table 1 Summary for the published paper in this project

Topic	SCI paper	Conference paper	in preparation	patent
HER	4			
H2 storage			2	1
H_2 biomedical application	1	2		

Representative References

[1] J.-R. Zhang, T.-S. Wu, H.-V. Thang, K.-Y. Tseng, **H.-Y. T. Chen*** & Y.-K. Peng*. Chemical state tuning of active sites over single-atom/cluster nanozymes: a balance between their maximum utilization and specific reactivity as peroxidase/oxidase mimetics. Small, (2021)..

[2] Haolin Li, Sheng Dai, Dinesh Bhalothia, Alice Hu*, Jyh-Pin Chou* and **Tsan-Yao Chen***. Interfacial atomic Ni tetragon intercalation in a NiO2-to-Pd hetero-structure triggers superior HER activity to the Pt catalyst, Journal of Materials Chemistry A, 9 (2021) 12019-12028.