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Light-Emitting Transition Metal Dichalcogenide Monolayers under Cellular Digestion

Two-dimensional (2D) materials cover a wide spectrum of electronic properties. Their applications have been extended from electronic, optical, and chemical to biological. Regarding biomedical uses of 2D materials, the interactions between cells and 2D materials are of paramount significance. However, bio-interfacial studies are still in their initial stages. This work studies how living organisms interact with transition metal dichalcogenide monolayers. For the first time, we observe cells digest tungsten disulfide (WS2) monolayer. After digestion, cells intake WS22 and become light-emitting. Also, these light-emitting cells are not only viable but are also able to pass fluorescent signals to their progeny cells during cell-division. By combining synthesis of 2D materials and a cell culturing technique, we develop a procedure to real-time monitor the interactions between WS2 monolayers and cells. This observation, with its procedures, opens the door to develop novel cellular labeling and imaging approaches and will trigger further studies on bio-interface between 2D materials and living organisms.

We report that LMH cells can digest fluorescent WS2 monolayers. After digestion, photoluminescence of the original WS2 monolayers is quenched, and LMH cells become light emitting. More importantly, light-emitting (fluorescent) cells are not only viable but also able to pass fluorescent signals to their progeny cells during cell division. This work sheds light on interfacing 2D materials with live organism, and in particular on utilizing the optical properties of semiconducting TMDs for developing next generation of cellular labeling and imaging. From a materials science perspective, this report also introduces an unprecedented approach to engineer structural defects of TMDs using cell digestion. These defective TMDs containing nanopores and vacancies may open up new possibilities of magnetism, basal plane functionalization, and enhanced catalytic performance in hydrogen evolution reactions, and DNA translocation through nanopores.