Hierarchical three dimensional (3D) microstructures integrated with low-dimensional nanomaterials can realize novel properties or improved performance. We report a unique conductive and highly ordered 3D silicon micro-mesh structure, which is fabricated by standard lithography using a modified plasma etch process. Zinc oxide (ZnO) nanowires are then integrated with the micro-mesh, and the density of ZnO nanowires (NWs) can be increased by around one order of magnitude compared with ZnO NWs on a 2D substrate. Owing to the high spatial density of ZnO NWs on the robust 3D silicon micro-mesh structures, improved photocatalytic activity and stability can be achieved. A remarkable enhancement of photocurrent response is also observed. The ZnO can be converted into ZnS NWs and ZnO@ZIF-8 as on the micromesh. This method is low-cost and compatible with traditional complementary metal–oxide–semiconductor industries, and provides new possibilities for a wide range of devices based on micro-nano-electro-mechanical and chemical systems.