Energy conversion schemes involving dihydrogen hold great potential for meeting sustainable energy needs, but widespread implementation cannot proceed without solutions that mitigate the cost of rare metal catalysts and the intrinsic $O_2$-instability of bio-inspired replacements. Recently, thick films (>100 µm) of redox polymers were shown to prevent $O_2$ catalyst damage (1, 2), but also resulted in unnecessary catalyst load and mass transport limitations (3). Here, we apply novel homogeneous thin films down to 3 µm (4) that provide $O_2$-immunity while achieving highly efficient catalyst utilization. Our empirical data is explained by modeling demonstrating that resistance to $O_2$ inactivation can be obtained for non-limiting periods of time when the optimal thickness for catalyst utilization and current generation is achieved even when using highly fragile catalysts such as the enzyme hydrogenase. We show that different protection mechanisms operate depending on matrix dimensions and intrinsic catalyst properties, and can be integrated together synergistically to achieve large and stable $H_2$ oxidation currents in the presence of $O_2$, potentially enabling a plethora of practical applications for bio-inspired catalysts in harsh oxidative conditions.