Supplementary Information

Functionalization Dependent Biodegradability of Two-Dimensional Antimonene by Peroxidases: Impact on Immune Modulation

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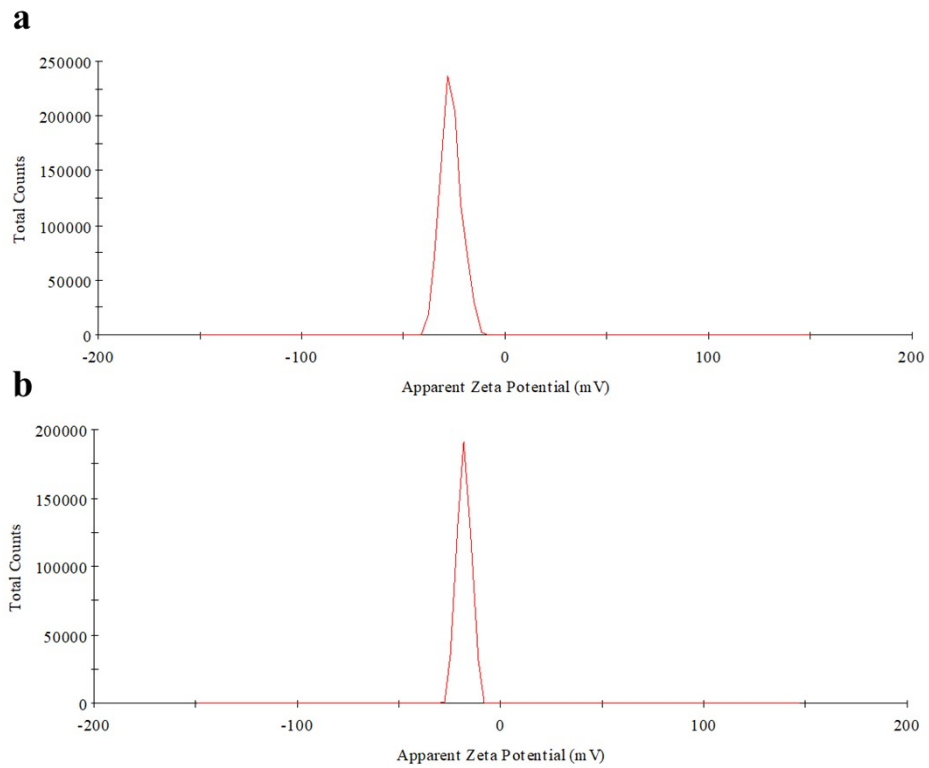

Figure S1 | Zeta potential graph of **a)** Sb nanosheets. **b)** *f*-Sb nanosheets

One important point to consider here is the role of van der Waals attractive forces and electrostatic repulsive forces responsible for maintaining the colloidal stability even with low Zeta Potential. The decrease in the less negative zeta potential of f-Sb NSs could also be attributed to weak van der Waals attractive forces in the non-covalent functionalization of Sb NSs with β-cyclodextrin [***S. Bhattacharjee / Journal of Controlled Release 235 (2016) 337–351***; *H. Kouchakzadeh, S.A. Shojaosadati, A. Maghsoudi, E. Vasheghani Farahani, Optimization of PEGylation conditions for BSA nanoparticles using response surface methodology, AAPS PharmSciTech 11 (2010) 1206–1211*]. Within a certain period of the functionalization protocol utilized in our case, the amount of β-cyclodextrin leads to a gradual decrease of the absolute value of the zeta potential of the whole complex. As a result, the electrophoretic mobility of the Sb NSs and f-Sb NSs changes upon the functionalization that is observed in the decrease of the negative zeta potential of the f-Sb NSs [*W. Wang et al. / Colloids and Surfaces B: Biointerfaces 148 (2016) 541–548*]. The functionalization of β-cyclodextrin with Sb NSs also induces a shift in the slipping pane of the surface charges upon the complex, leading to a decrease in the lower absolute value.

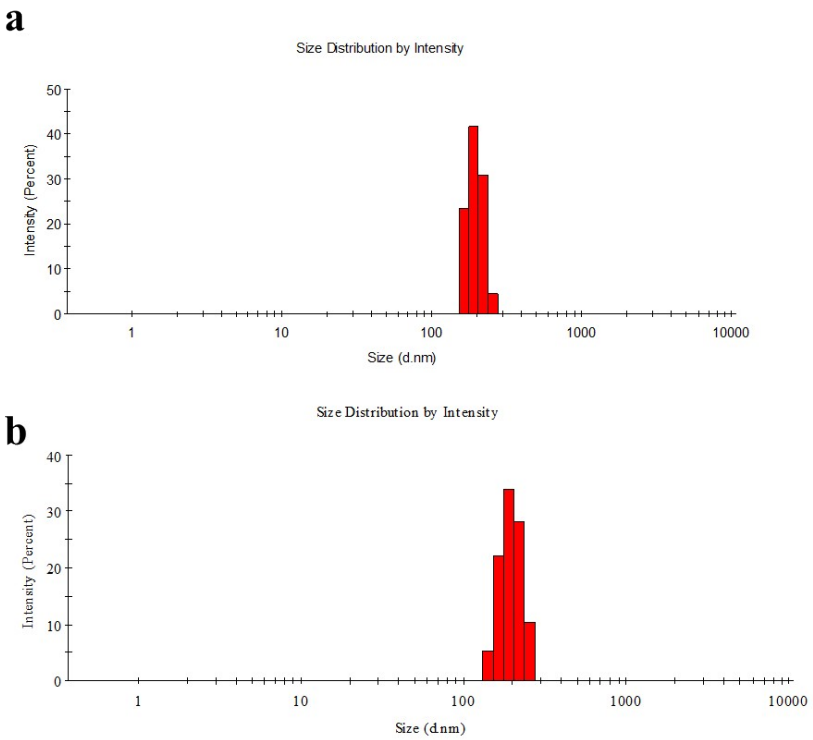

Fig S2 | Size measurement graph of a) Sb nanosheets and b) *f*-Sb nanosheets, respectively.

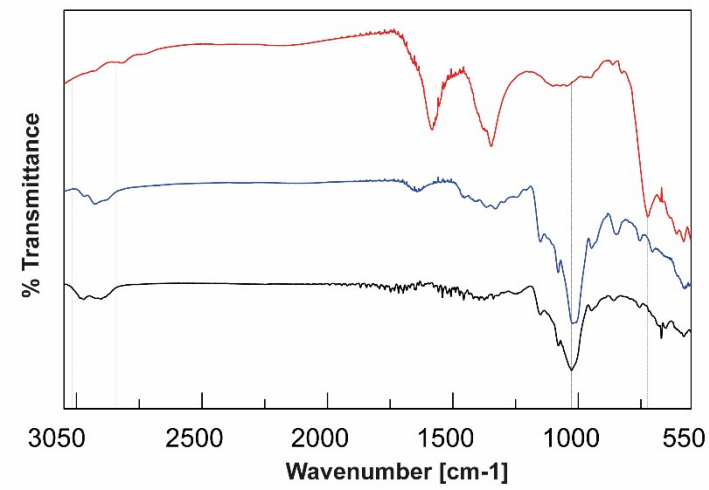

Figure S3. Enlarged FTIR spectra of Sb sheets (red line) β-cyclodextrin (blue line) and *f*-Sb nanosheets (black line). The β-CDs band around 1015 cm^{-1}, besides a slight wavelength shift to 1024 cm^{-1}, also exhibited a relative decrease in the intensity, in comparison with that around 2900 cm^{-1} and the ratio between the area of these bands changed from 13:1 in CD to 5:1 in *f*-Sb nanosheets. The overall data supported the involvement of oxygen-containing functional groups of β-CDs in the interaction with Sb nanosheets.

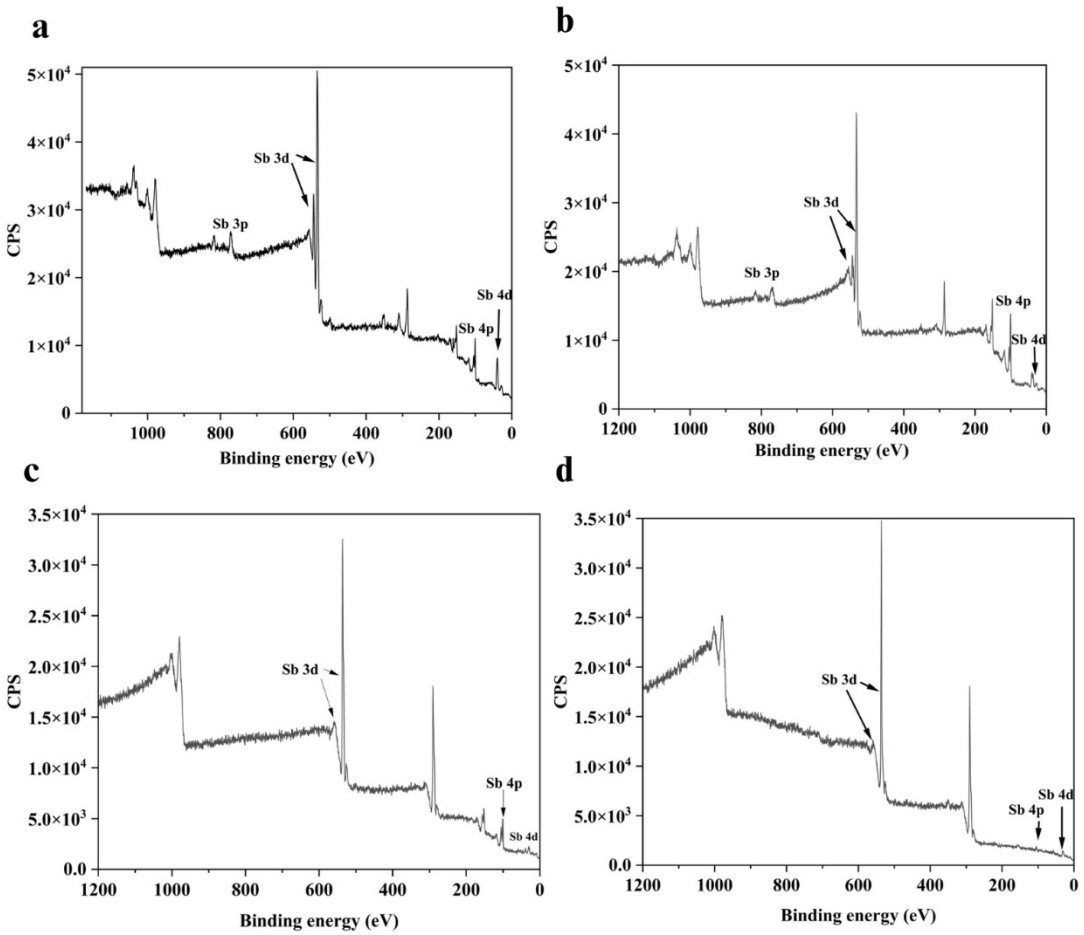

Figure S4 | XPS Survey spectra of Sb nanosheets **a)** at 0 day**,** and **b)** after 7 days in buffer. *f*-Sb nanosheets **c)** at 0 day, and **d)** after 7 days in buffer.

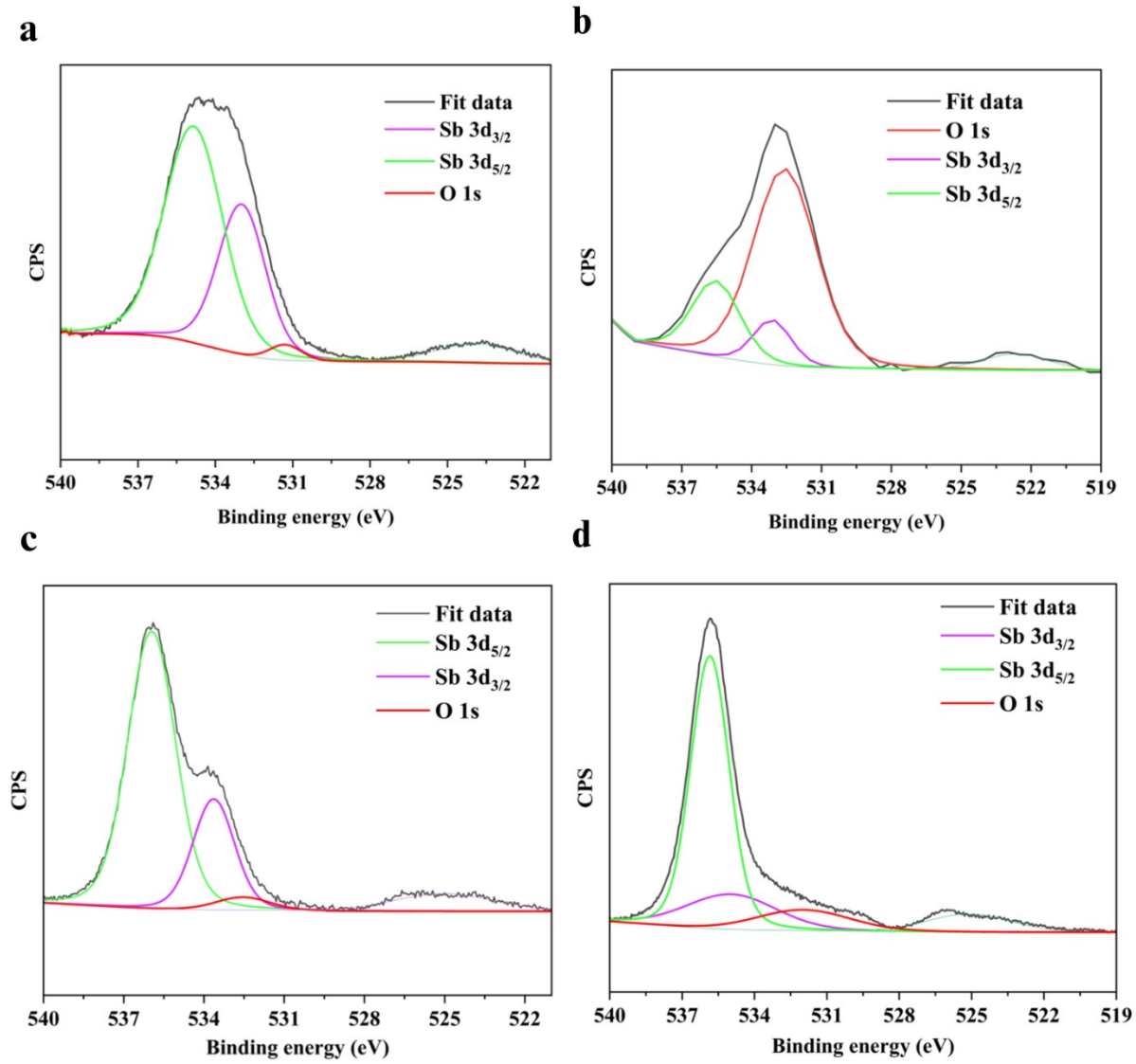

Figure S5 | XPS spectra of Sb nanosheets **a)** at 0 day**,** and **b)** after 7 days in buffer. *f*-Sb nanosheets **c)** at 0 day, and **d)** after 7 days in buffer.

Table S1 Main features retrieved by **Figure S5**:

	Spectral range(eV)	area		%area	
Sb nanosheets					
		Before	After	Before	After
O1s	520~540	28552.29	78722.13	16.25	56.40
Sb $3d_{5/2}$		116895.39	14608.85	66.51	10.47
Sb $3d_{3/2}$		20991.10	38278.74	11.94	27.41
Sb MNN		9288	7967.83	5.29	5.72
f-Sb nanosheets					
		Before	After	Before	After
O1s	520~540	566.93	4481.03	1.69	12.54
Sb $3d_{5/2}$		9119.44	5768.2	27.17	16.14
Sb $3d_{3/2}$		21099.14	22373.47	62.83	62.58
Sb MNN		2788.64	3120.54	8.32	8.72

The XPS spectra may show an increase in the intensity of the O 1s peak and a shift in the Sb 3d peaks towards higher binding energies, indicating the formation of surface oxides, as reported in literature https://doi.org/10.1088/2053-1583/ab755e https://doi.org/10.1039/C9TA13485A. The progressive decrease in the intensity of metallic Sb as sonication time increases. This is expected because longer sonication times lead to more extensive exfoliation, resulting in thinner nanosheets with higher surface areas that are more prone to oxidation. The intensity ratio of the main peaks (I_{532eV}/I_{540eV}) is not constant and increases with time. Oxygen is adsorbed as a surface species during the liquid phase exfoliation (LPE) process or after exposure to ambient conditions.

We are exfoliating it for a long time in water and spectra is a little bit shifted than the cited spectra as reported in https://doi.org/10.1088/2053-1583/ab755e In the XPS spectra of antimonene nanosheets, a broad feature observed between 520–524 eV can be attributed to the Sb MNN Auger transition. This overlap with the Sb 3d core-level region arises due to the energy transformation from kinetic energy to binding energy in XPS. Such contributions are particularly pronounced in samples with surface oxidation or mixed chemical states, as previously reported https://doi.org/10.1002/sia.2005

Given these findings, we believe that the differences in our XPS spectra are due to the progressive oxidation and surface adsorption of oxygen species, as described above.

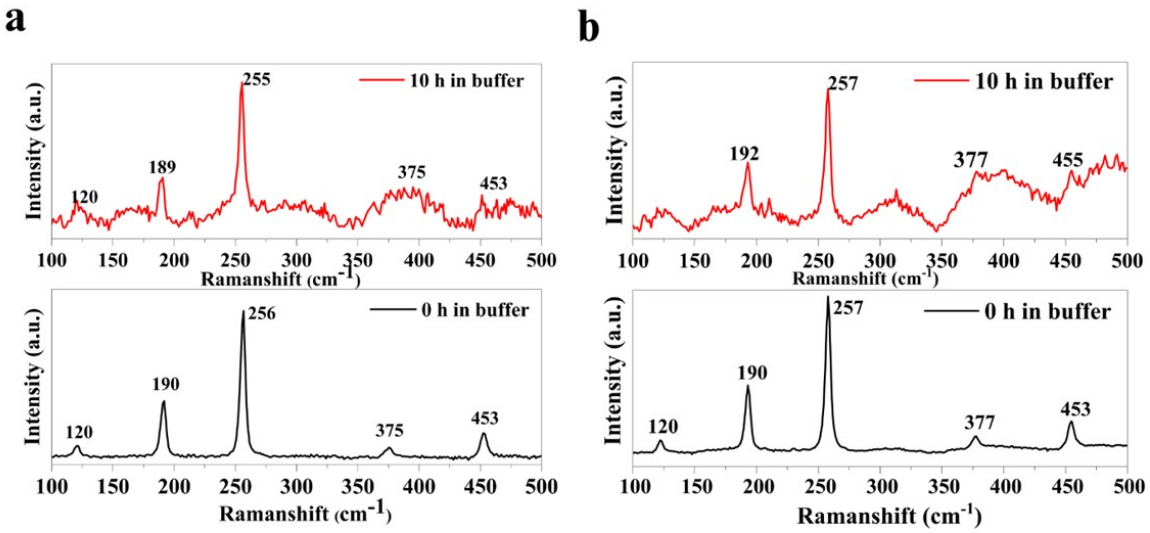

Figure S6 | **a)** Separated Raman spectra of Sb nanosheets as control samples for hMPO degradation, 0 h and 10 h. **(b)** Separated Raman spectra of *f*-Sb nanosheets as control samples for hMPO degradation, 0 h and 10 h.

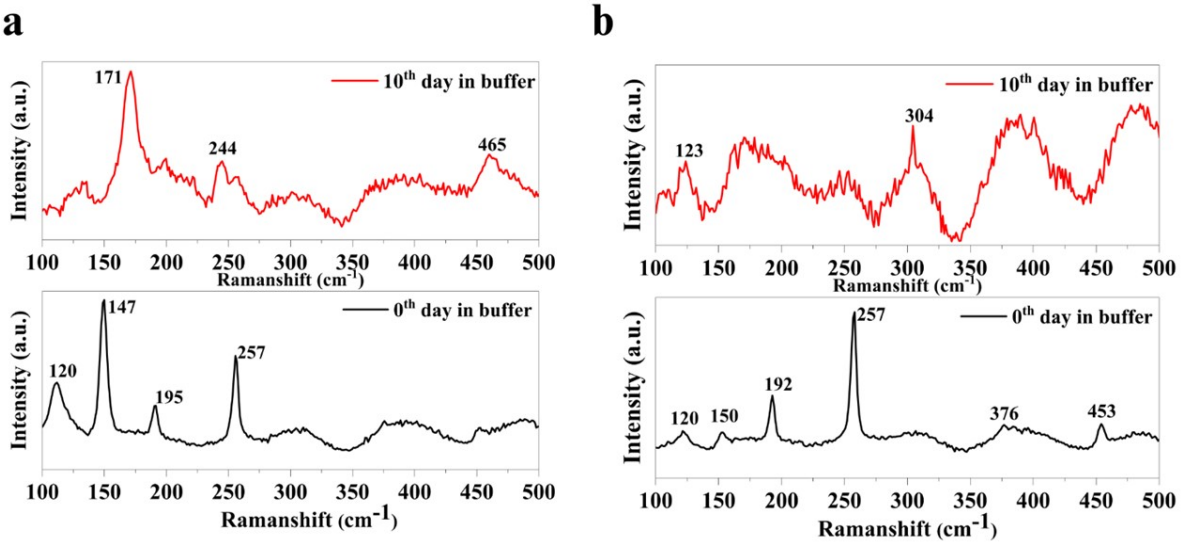

Figure S7 | **a)** Separated Raman spectra of Sb nanosheets as control samples for HRP degradation, 0 h and 10 h. **(b)** Separated Raman spectra of *f*-Sb nanosheets as control samples for HRP degradation, 0 h and 10 h.