Supplementary Information (SI)

A nanoscale study of the structure and electrical response of Sepia eumelanin

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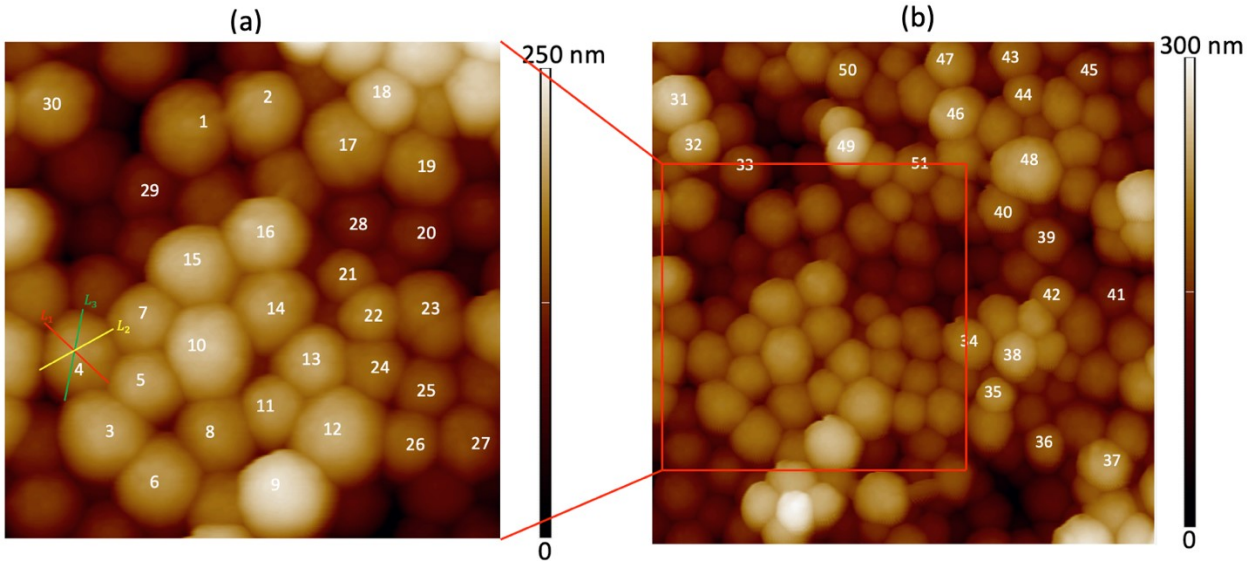

Figure S1. (a) 1.2 μmx1.2 μm- and (b) 2 μmx2 μm-sized AFM images of drop casted Sepia showing 50 granules over which granule diameters and protrusions' sizes (height and width) were measured. Lines L_1, L_2, and L_3 indicate the directions in which diameter values were measured for granule 4. See Table S2 for the diameters. See Table S3 for protrusions' sizes.

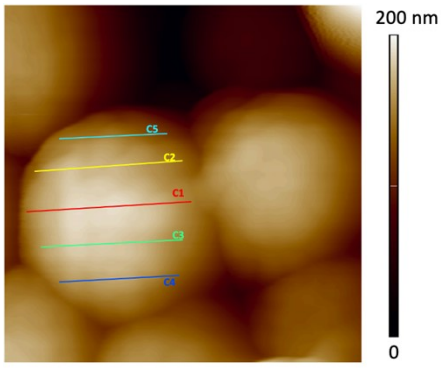

Figure S2. Lines considered to measure protrusions size on granule 1 (see Figure S1).

Calculations of the size of the protrusions

In Figure 4 (b), the radius of the circle containing the fitting data is 123.6 nm. The center of this semicircle is at (881.7, - 646.7) nm.

The height of Protrusion 1 is calculated by considering the distance from the highest point of the protrusion to the center of the circle minus the radius:

$\sqrt{(490.4 - 881.7)^2 + (590.8 - (-646.7))^2}$ - 123.6= 6.2 nm

Along this line, the height of Protrusion 2 is:

$\sqrt{(965.3 - 881.7)^2 + (624.8 - (-646.7))^2}$ -123.63=3.8 nm

The width of the protrusions was measured as the full width at half maximum (FWHM), for each protrusion.

The width of Protrusion 1 is therefore $width_1 = FWHM_1$= 23.3 nm

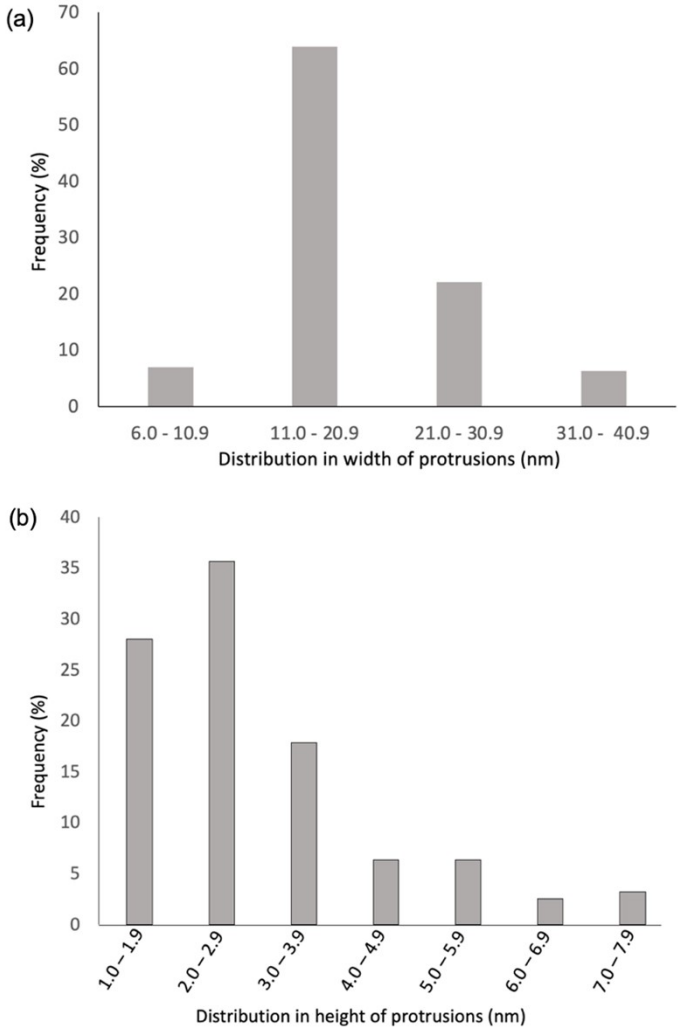

Figure S3. Histograms of distribution in (a) width and (b) height of protrusions of Sepia eumelanin granules from Table S3.

Table S1. Characteristics of the samples measured by AFM for this study.

Sample	AFM characterization	Deposition method	Scanned area	Figure
Sample 1	AFM (Topography)	Spin coating (Sepia eumelanin-PVB ink)	2.5 μmx2.5 μm 1 μmx1 μm 600 nmx600 nm	-
Sample 2		Spin coating (Sepia eumelanin-PVB ink)	700 nmx700 nm 700 nmx700 nm	-
Sample 3		Spin coating (Sepia eumelanin-PVB ink)	3 μmx3 μm 1 μmx1 μm	Figure 5. (a) Figure 5. (b)
Sample 4		Spin coating (Sepia eumelanin-PVB ink)	20 μmx20 μm 5 μmx5 μm 1.5 μmx1.5 μm 700 nmx700 nm	-
Sample 5		Spin coating (Sepia eumelanin-PVB ink)	20 μmx20 μm 5 μmx5 μm	-
Sample 6		Spin coating (Sepia eumelanin-PVB ink)	2 μmx2 μm 500 nmx500 nm	-
Sample 7		Drop casting (Extracted Sepia eumelanin)	2 μmx2 μm 1.2 μmx1.2 μm 400 nmx400 nm	Figure S1. (b) (SI) Figure 2. (a) Figure 2. (b)
Sample 1	c-AFM	Spin coating (Sepia eumelanin-PVB ink)	2.5 μmx2.5 μm 1 μmx1 μm 600 nmx600 nm	-
Sample 2		Spin coating (Sepia eumelanin-PVB ink)	700 nmx700 nm 700 nmx700 nm	-
Sample 3		Spin coating (Sepia eumelanin-PVB ink)	1 μmx1 μm	Figure 5. (b)

Table S2. Diameters of granules measured from drop cast Sepia eumelanin. The average is calculated over granules with size in the considered interval.

Range of measured Granules' diameters (nm)	Average diameter of granules (nm)	Frequency (%)
120 - 129	122 $\pm$ 4	2
140 -149	143 $\pm$ 4	2
150 - 159	155 $\pm$ 7	12
160 - 169	166 $\pm$ 6	4
170 - 179	177 $\pm$ 12	8
180 - 189	183 $\pm$ 7	4
190 - 199	194 $\pm$ 4	6
200 - 209	204 $\pm$ 11	20
210 - 219	216 $\pm$ 7	10
220 - 229	223 $\pm$ 16	14
230 - 239	232 $\pm$ 12	6
240 - 249	244 $\pm$ 11	6
250 - 259	257 $\pm$ 12	4
290 - 300	291 $\pm$ 10	2

Table S3. Height and width of protrusions characterizing the surface morphology of Sepia eumelanin granules indicated in Figure S1.

Granule number	Profile's line and associated protrusions		Height (nm)	Width (nm)
1	C1G1	Protrusion 1	6.2	23.3
		Protrusion 2	3.8	18.9
	C2G1	Protrusion 1	2.9	21.3
		Protrusion 2	6.9	25.2
		Protrusion 3	9.3	29
	C3G1	Protrusion 1	4.7	21.6
	C4G1	Protrusion 2	4.9	26.7
		Protrusion 3	3.8	20
	C5G1	Protrusion 1	5.7	26.7
		Protrusion 2	1.6	9.4
		Protrusion 3	2.4	15.6
2	C1G2	Protrusion 1	2.7	11.7
		Protrusion 2	1.9	10.1
	C2G2	Protrusion 1	1.1	6.1
		Protrusion 2	1.6	11.5
	C3G2	Protrusion 1	1.4	9.8
		Protrusion 2	2.6	17.7
	C4G2	Protrusion 1	2.5	14.8
		Protrusion 2	2.6	20.5
3	C1G3	Protrusion 1	5	18
		Protrusion 2	3.2	18.5
		Protrusion 3	3.5	20.3
	C2G3	Protrusion 1	3.2	29.3
		Protrusion 2	3.3	21.1
		Protrusion 3	2.6	16.5
	C3G3	Protrusion 1	3.1	28.7
		Protrusion 2	3.3	22.8
		Protrusion 3	2.4	17.8
4	C1G4	Protrusion 1	2.7	18.8
		Protrusion 2	5.4	26.9
	C2G4	Protrusion 1	7.8	31.3
		Protrusion 2	6.7	36.2
		Protrusion 3	1.8	7.8
5	C1G5	Protrusion 1	2.6	14.7
		Protrusion 2	3.6	23.5
	C2G5	Protrusion 1	2.5	14.2
		Protrusion 2	1.3	11
	C3G5	Protrusion 1	6.9	17.5
		Protrusion 2	1.2	12.7
6	C1G6	Protrusion 1	4.8	22.7
		Protrusion 2	1.6	15.5
	C2G6	Protrusion 1	3.4	17.4
		Protrusion 2	2	15.4
	C3G6	Protrusion 1	3.8	26.3
		Protrusion 2	3.8	15.3
		Protrusion 3	2	10.2
7	C1G7	Protrusion 1	1.7	14.1
	C2G7	Protrusion 1	1.2	13.3
		Protrusion 2	3.2	14.9
	C3G7	Protrusion 1	2.2	17.6
		Protrusion 2	1.2	15.7
8	C1G8	Protrusion 1	2.3	14

		Protrusion 2	1.9	13.6
	C2G8	Protrusion 1	3.8	16.8
	C3G8	Protrusion 1	3	16.2
		Protrusion 2	2.5	16.4
9	C1G9	Protrusion 1	2	17.4
		Protrusion 2	3	18.6
	C2G9	Protrusion 1	2.5	16
		Protrusion 2	2.6	15.8
	C3G9	Protrusion 1	1.4	12.7
		Protrusion 2	2.5	19.3
		Protrusion 3	2	17.8
10	C1G10	Protrusion 1	4.9	30
		Protrusion 2	1.8	11.1
	C2G10	Protrusion 1	2.1	13.4
		Protrusion 2	1.7	11.7
		Protrusion 3	3.6	28
	C3G10	Protrusion 1	3.2	17.6
		Protrusion 2	5.3	22.8
		Protrusion 3	3.3	17.8
11	C1G11	Protrusion 1	5.8	31.9
		Protrusion 2	2.3	17.3
	C2G11	Protrusion 1	1.9	20.2
	C3G11	Protrusion 1	2.2	22.7
12	C1G12	Protrusion 1	2.8	17.9
		Protrusion 2	2.8	37.7
	C2G12	Protrusion 1	2.7	23.5
		Protrusion 2	1.2	16.3
		Protrusion 3	4	17.8
	C3G12	Protrusion 1	2.8	18
		Protrusion 2	1.6	12.6
13	C1G13	Protrusion 1	3.3	19.8
		Protrusion 2	2.9	7.9
		Protrusion 3	2.8	26.6
	C2G13	Protrusion 1	2.8	17.8
		Protrusion 2	4.3	22.6
14	C1G14	Protrusion 1	4.9	32.5
		Protrusion 2	2.8	17.6
		Protrusion 3	1.6	17.9
	C2G14	Protrusion 1	2.2	15.6
		Protrusion 2	1.1	11.4
	C3G14	Protrusion 1	2	15.4
	C4G14	Protrusion 1	1.2	10.3
15	C1G15	Protrusion 1	1.1	9.3
		Protrusion 2	2.8	19.2
		Protrusion 3	1.3	15.5
	C2G15	Protrusion 1	1.5	16
	C2G15	Protrusion 2	1.1	12.4
	C3G15	Protrusion 3	2.5	25
		Protrusion 2	2.4	22.3
	C4G15	Protrusion 1	2.8	20.2
	C5G15	Protrusion 1	1	11.1
		Protrusion 2	1.9	25.7
16	C1G16	Protrusion 1	2	11.5
		Protrusion 2	1	13.8
	C2G16	Protrusion 1	2.7	19.8
		Protrusion 2	5.1	27.6

17	C1G17	Protrusion 1	3.9	18
		Protrusion 2	5	21.6
		Protrusion 3	1.4	11.7
	C2G17	Protrusion 1	7	40.1
		Protrusion 2	3.2	21.9
	C3G17	Protrusion 1	2.4	11.6
		Protrusion 2	2.3	15.9
		Protrusion 3	1.7	9.8
18	C1G18	Protrusion 1	2.7	13
		Protrusion 2	3.3	12
	C2G18	Protrusion 1	3.7	14.3
		Protrusion 2	3.9	15.5
		Protrusion 3	2.6	14.2
19	C1G19	Protrusion 1	7.6	30.9
		Protrusion 2	1.9	16.2
		Protrusion 3	4.7	32.7
	C2G19	Protrusion 1	5.1	29.5
20	C1G20	Protrusion 1	2.1	11.3
	C2G20	Protrusion 1	4.3	27.1
		Protrusion 2	4	27.4
21	C1G21	Protrusion 1	2	16.5
		Protrusion 2	1.5	12.6
	C2G21	Protrusion 1	1.8	18.6
		Protrusion 2	2.2	11
22	C1G22	Protrusion 1	7.8	28
	C2G22	Protrusion 1	2.7	15.9
23	C1G23	Protrusion 1	5.4	39.4
		Protrusion 2	7.3	31.6
	C2G23	Protrusion 1	2.5	18.5
		Protrusion 2	3.1	18
		Protrusion 3	2.1	20.7
24	C1G24	Protrusion 1	1.2	15.8
		Protrusion 2	2.5	18.4
	C2G24	Protrusion 1	1.5	13.4
		Protrusion 2	3.6	27.6
25	C1G25	Protrusion 1	1.6	14
		Protrusion 2	2.2	21.5
	C2G25	Protrusion 1	2.3	17.8
		Protrusion 2	2.3	12.3
26	C1G26	Protrusion 1	1.4	11.5
		Protrusion 2	1	13.4
		Protrusion3	1	11.4
		Protrusion 4	3.1	33.9
	C2G26	Protrusion 1	1.5	9.6
		Protrusion 2	1.4	14
27	C1G27	Protrusion 1	2.3	14.3
		Protrusion 2	5.7	40.7
	C2G27	Protrusion 1	2	14.7
		Protrusion 2	1.9	13.9