Analysis of titanium dioxide and zinc oxide nanoparticles in cosmetics

OBJECTIVE

Evaluate the size parameters of NPs in six different commercial sunscreens by TEM, AFM, LSCM, and XRD. Analytical results were compared to assess the effectiveness of these methods in characterizing NP-based cosmetics.

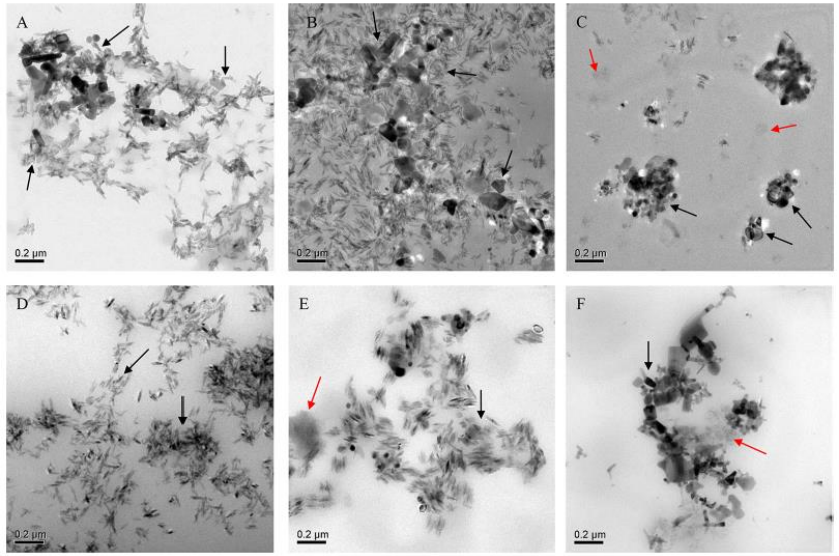
SAMPLE PREPARATION

After shaking commercial sunscreens, aliquots of sunscreens were taken from the bottle and diluted with ethanol. A drop (10 mL) of the resulting dispersions was deposited onto a carbon-coated copper grid wicked using filter paper, and air-dried at room temperature.

DATA ACQUISITION

Particle sizes and shapes were analyzed at acceleration voltage of 200 kV and magnifications of 10,000-20,000x. Elemental compositions were determined by energy-dispersive X-ray spectroscopy (EDS).

REPRESENTATIVE FIGURE AND RESULT



(A) COM 1, (B) COM 2, (C) COM 3, (D) COM 4, (E) COM 5 (F) COM 6. Black and red arrows indicated metal oxide NPs and the formulation matrix, respectively.

The six samples contained TiO_2 and ZnO particles exhibiting at least one dimension smaller than 100 nm.

Product No.	TEM		
	Particle size (nm)	Particle shape	Elements detected by EDS
COM 1	30–85 (length) 10–20 (width)	Needle shaped	Ti, Zn, C, O, Al, Si, (Cu)
	50–110 (length) 25–90 (width)	various	
COM 2	45–85 (length) 10–15 (width)	Needle shaped	Ti, Zn, C, O, Al, Si, (Cu)
	35–245 (length) 20–65 (width)	various	
COM 3	20–290 (length) 20–85 (width)	various	Zn, C, O, Al, Si, (Cu)
COM 4	45–95 (length) 10–20 (width)	Needle shaped	Ti, C, O, Al, Si, (Cu)
COM 5	25–100 (length) 20–80 (width)	Spherical	Ti, C, O, Al, Si, (Cu)
	60–95 (length) 10–15 (width)	Needle shaped	Ti, C, O, Al, Si, (Cu)
COM 6	20–285 (length) 15–85 (width)	various	Zn, C, O, Si, (Cu)
TiO_2 NP standard	4–48 (length) 3–40 (width)	various	Ti, C, O, (Cu)
ZnO NP standard	8–47 (length) 8–47 (width)	Spherical	Zn, C, O, (Cu)

Rutile TiO_2 NPs exhibited needle-like shapes in COM 1, COM 2, and COM 4. Therefore, in COM 5, anatase and rutile TiO_2 NPs were deduced to show spherical and needle-like shapes, respectively.

CONCLUSION

XRD and TEM identified TiO_2 and ZnO NPs sizes in these samples and gave complementary information about characterizing NPs. TEM was able to show the particle size, shape, and composition of commercial sunscreens. TEM can resolve the NPs in the matrix, but samples needed dilution before the observation. The dilution condition may alter the NPs and cannot analyze the aggregation/agglomeration state in the final products.

REFERENCE

Lu, Pei-Jia et al, "Analysis of titanium dioxide and zinc oxide nanoparticles in cosmetics", *Journal of food and drug analysis,* vol. 23, pp. 587-594, 2015.