

● Table 2. Summary of Different Nanomaterials Used in Cosmetics and Their Possible Advantages and Disadvantages (20, 23–25)

Types of Nanomaterials				Advantages and Disadvantages	
Organic Nanoparticles					
Lipid and surfactant-derived nanoparticles	Vesicular	Liposome	Vesicles composed of a bilayer of phospholipids	Advantages: Biodegradable, biocompatible, amphiphilic (ability to compartmentalize and solubilize both hydrophilic and lipophilic materials) and higher skin penetration	
				Disadvantages: Lower medication stacking; lower reproducibility and lower chemical stability; may trigger an immune response	
		Ethosome	Liposome formulation with inclusion of a very high concentration of ethanol	Advantages: Higher efficiency and penetration of cosmetic delivery into the skin	
				Disadvantages: Poor yield problems, stability and possibility of coalescence	
		Transferosome	Liposome formulation with inclusion of edge activators (i.e. softening surfactants)	Advantages: Superior penetration through skin barrier	
	Non-vesicular	Niosome	Vesicles composed of non-ionic surfactants	Advantages: Cheaper raw materials; higher efficiency, penetration, bioavailability and prolonged stability of drugs (especially when compared to phospholipid-based vesicles)	
				Disadvantages: Higher cost of production; physical and chemical instability; leakage of the drug; time-consuming production	
		Solid lipid nanoparticles	Inner lipid core (solid at body temperature) formed only by solid lipids prepared by microemulsion and high-pressure homogenization	Advantages: Potential carriers of chemically labile molecules; occlusive properties that promote skin hydration and penetration of bioactive agents; higher duration of action, ease of large-scale production; higher bioavailability and biodegradability	
				Disadvantages: Lower shelf life and decreased drug encapsulation	
	Nanostructured lipid carrier	Inner lipid core (solid at body temperature) formed by solid and liquid lipids prepared by microemulsion and high-pressure homogenization	Advantages: Potential carriers of chemically labile molecules; occlusive properties that promote skin hydration and penetration of bioactive agents; the inclusion of oils in lipid matrix decreases crystallinity, improving loading capacity, long-term encapsulation and stability of the system leading to higher shelf life, ease of large-scale production		
			Disadvantages: Lower duration of action		
	Nanoemulsion (o/w)	Biphasic systems composed of oil-phase and liquid-phase and one or more emulsifying agents	Advantages: If non-ionic surfactants are used, results in more stability against agglomeration and precipitation and the large interfacial area displayed by their droplets makes the material transfer faster, enhancing delivery performance, fluid and transparent appearance and amphiphilic		
			Disadvantages: Less thermodynamic stability when compared to microemulsion; more difficult to prepare; acid sensitive; lower duration of action		
Polymeric	Nanosphere	Polymeric matrix in which numerous active ingredients can be entrapped or into which they can be adsorbed		Advantages: Improved performance of chemically labile, poorly water-soluble or volatile molecules; sustained release of the loaded active molecules prolonging their beneficial effects	
Nanoparticles	Nanocapsule	Liquid core surrounded by polymeric shell – the inner core holds the bioactive agent while the polymeric shell controls its release		Advantage: Improved performance of chemically labile, poorly water-soluble or volatile molecules; protection of ingredients; masking of undesirable odors; sustained release of the loaded active molecules; resolution of incompatibility issues between formulation components; sustained release formulation	
				Disadvantages: An additional purification step is required after nanocapsule formation	
Nanocrystals	Clusters made up of thousands of molecules joined together in a fixed pattern to form a group with sizes ranging from 10 to 400 nm stabilized by surfactant/polymeric coating			Advantages: Possible solution to poorly water-soluble agents; large surface area and poor crystallinity lead to higher drug solubility, particle distribution, adhesivenes, and dissolution rate; 100% drug loading ability	
				Disadvantages: Possibility of aggregation; not appropriate for aqueous APIs; only stable to a certain extent	
Dendrimers	Three-dimensional nanostructured macromolecules that are extensively branched			Advantages: Higher solubility of lipophilic drugs; controlled-release drug formulation; maintenance of the stability of the drug in cosmetic formulations; higher shelf life of formulation	
				Disadvantages: Not good materials for hydrophilic drugs; cellular toxicity; higher manufacturing cost	
Inorganic Nanoparticles					
Titanium dioxide and zinc oxide	Inorganic UV radiation filters			Advantages: TiO2 has a higher sun protection factor at the nanoscale, which makes it more effective and results in a superior restorative effect due to its transparency, in contrast with its original color due to the large surface-area-to-volume ratio	
	ZnO : more effective for UVA			Disadvantages: Inhalation of a large amount of these NPs is harmful	
	TiO2: more effective for UVB				
Gold and silver	Gold NPs play a substantial role in fixing skin damage and improving skin surface, grace and flexibility.			Advantages: Stability, biocompatibility, antifungal, antibacterial and anti-aging benefits	
	Silver nanoparticles can be used as successful inhibitors of various microorganisms.			Disadvantages: The safety of colloidal silver in nanostructures concerning its use in oral and dermal cosmetic items is ambiguous	
Silica	Mainly composed of amorphous silica nanodispersions with a size range of 5 nm to 100 nm; can deliver both hydrophilic and lipophilic entities to their respective targets by encapsulation			Advantages: Hydrophilic surfaces favor extended distribution and low manufacturing costs; improve the adequacy, surface and shelf life of cosmetics	
				Disadvantages: Concerns about their safety; size and surface changes are factors must be considered while surveying its toxicity	
Carbon Black	Colorant - CI77266			Advantages: Micron-sized NPs have a lower propensity of causing cytotoxicity, aggravation and changes in phagocytosis in human monocytes when compared to NPs	
				Disadvantages: Can be used in cosmetic items when there is no danger of being breathed in	
tris-Biphenyl triazine	Novel, powerful and photostable filter			Advantages: Broad-spectrum UV protectant	
				Disadvantages: Not dangerous if applied to solid, unbroken skin; concerns related to possible harmful impacts with the potential to bioaccumulate in selected tissues	
Bucky Balls (Buckminsterfullerene/ C60)	Carbon fullerene is a three-dimensional spherical compound that comprises a carbon ring with an odd number of atoms			Advantages: Antioxidative properties (potent scavenging ability of free radical oxygen species)	
				Disadvantages: Fullerenes alone have limited applications due to their hydrophobic nature but the use of surface-active agents in a suitable concentration has improved their aqueous solubility	