Synopsis of Original Research Paper

Development of an air flow type plasma reactor for surface modification of cosmetic particulate materials

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Micron-sized powders are widely used in cosmetics to improve optical and tactile properties. However, their high tendency to aggregate often requires chemical dispersants, which may compromise safety and sustainability. To address this issue, we developed an air flow type plasma reactor for continuous, non-contact surface modification of particulate materials without chemical additives. This study evaluates two reactor configurations—linear and spiral—for the plasma treatment of polyethylene (PE) particles (~3μm diameter). The spiral reactor, designed without internal electrodes, minimizes particle deposition and avoids issues like thermal melting and clogging, which were observed in the linear reactor. Surface wettability was assessed by contact angle measurements and FT-IR spectroscopy, confirming the introduction of hydrophilic functional groups such as hydroxyl (– OH) groups on the particle surface. Experimental results revealed that the particle concentration in the reactor strongly influences treatment performance. A lower particle number led to a significant decrease in contact angle, indicating enhanced hydrophilicity. However, a trade-off was found between treatment efficiency and throughput. Additionally, scanning electron microscopy showed that particles remained partially aggregated after treatment, suggesting incomplete exposure to plasma. To improve overall processing efficiency, future work will explore advanced dispersion and feeding systems, such as aerosol generators, to ensure a more uniform plasma exposure. These findings support the feasibility of plasma-based dry surface modification as an environmentally friendly alternative to conventional chemical treatments in cosmetic powder production.