Surface Activation of Spent Coffee Grounds by DCSBD Plasma for Potential Use as Sustainable Rubber Filler

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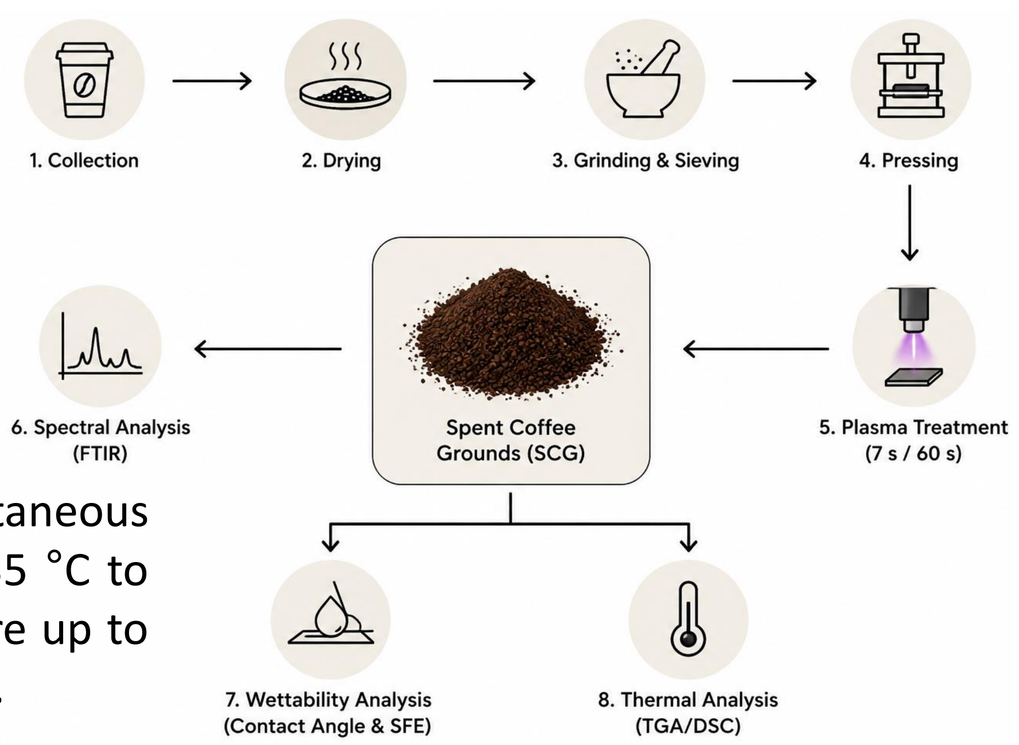
➢ INTRODUCION

Spent coffee grounds (SCG) represent a promising **sustainable biofiller** with **significant potential for advanced elastomer applications** and circular material utilization. This research demonstrates **the capability of DCSBD plasma to enhance the surface activity, wettability, and interfacial behaviour** of bio-based fillers for **environmentally friendly rubber technologies.**

➢ METHODS

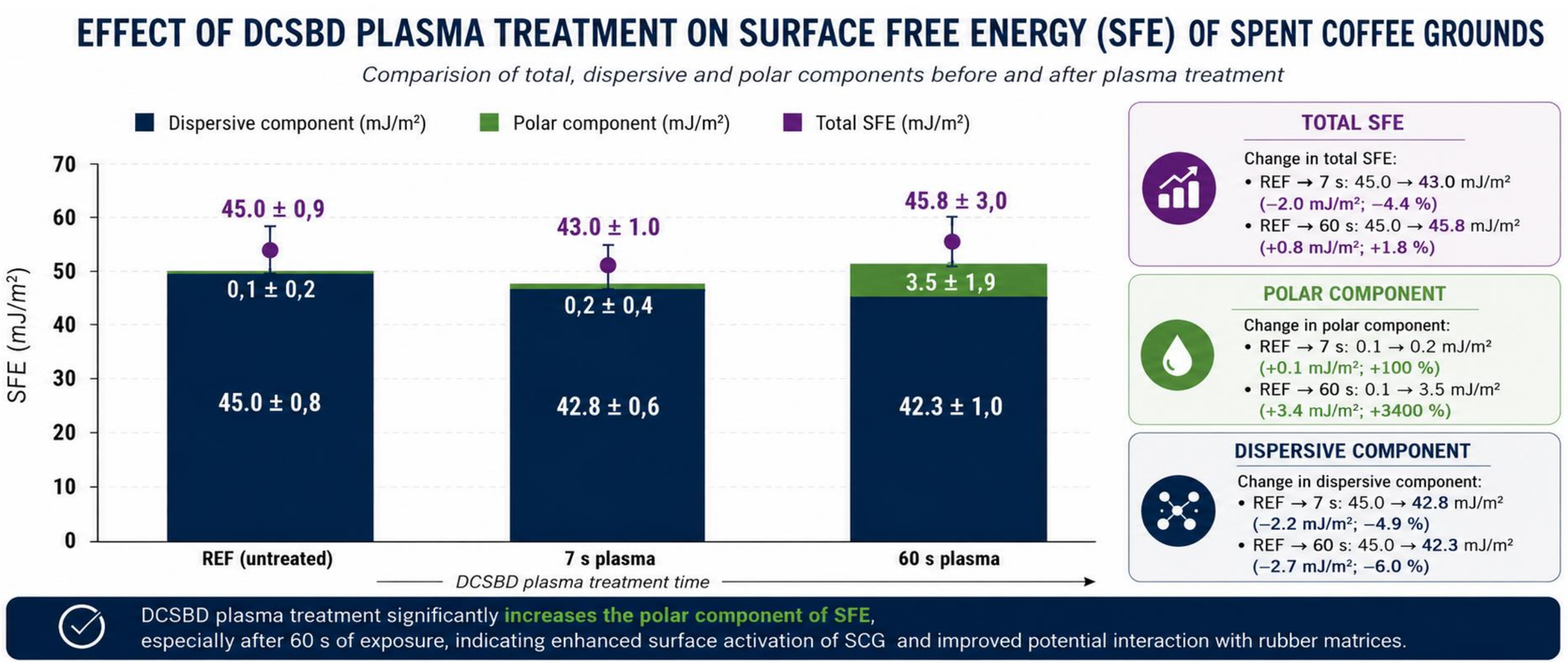
The prepared spent coffee grounds (SCG) were dried, mechanically processed, sieved, and compressed into compact plates. Surface modification was performed using DCSBD plasma **treatment with exposure times of 7 s and 60 s.**
The prepared samples were subsequently characterized by contact angle and surface free energy measurements, FTIR spectroscopy, TG/DSC thermal analysis, and optical image analysis to evaluate the physicochemical and surface properties of the plasma-modified biofiller.

- **DCSBD plasma** treatment was performed under atmospheric-pressure ambient air conditions using a diffuse coplanar surface barrier discharge reactor operated at an input power of 375 W, with exposure times of 7 s and 60 s to modify the surface properties of spent coffee grounds.
- **Contact angle (CA)** and **surface free energy (SFE)** measurements were performed using a Drop Shape Analyzer DSA100 system based on the sessile drop method.
- Thermal behaviour was evaluated using a NETZSCH STA simultaneous TG/DSC analyser under controlled heating conditions from 35 °C to 800 °C at a heating rate of 20 °C/min, in nitrogen atmosphere up to 450 °C followed by oxygen atmosphere from 450 °C to 800 °C.



➢ THE RESULTS

DCSBD plasma treatment increased the polar component of the surface free energy of spent coffee grounds, indicating successful surface activation and improved potential interaction with elastomer matrices. Plasma-modified SCG also exhibited improved wettability behaviour and reduced water contact angle after 60 s exposure. FTIR analysis confirmed plasma-induced chemical modification through the formation of oxygen-containing functional groups associated with enhanced surface reactivity.



The presented experimental workflow demonstrated that waste-derived biofillers can be physically processed, plasma-activated, and systematically characterized using advanced surface and thermal analytical methods applicable to sustainable elastomer technologies.

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