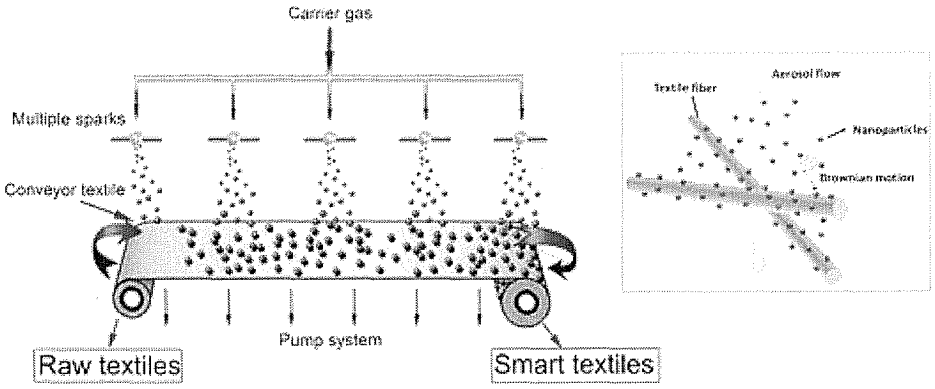
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Revolutionizing smart textile nanofinishing in a green fashion

(*Nanowerk Spotlight*) A major challenge in nanotechnology is that of determining how to introduce green and sustainable principles when assembling individual nanoscale elements to create working devices. For instance, textile nanofinishing is restricted by the many constraints of traditional pad-dry-cure processes, such as use of costly chemical precursors to produce nanoparticles, high liquid and energy consumption, production of harmful liquid wastes, and multistep batch operations. By integrating low-cost, scalable, and environmentally benign aerosol processes of the type proposed in our recent article published in *ACS Applied Materials & Interfaces* ("Scalable and Environmentally Benign Process for Smart Textile Nanofinishing"), involving more than 10 international institutes, the aforementioned constraints can be circumvented while leading to a new class of multifunctional fabrics.



Conceptual design of a simple, scalable and green route for textile nanofinishing, achieved by integrating electrical discharges for the synthesis of nanoparticles into roll-to-roll textile production. An aerosol flow is passed through the textile, where the nanoparticles collide and stick to the fibers by van der Waals forces. Brownian motion of the nanoparticles facilitates the deposition of them on fibers. (Reprinted with permission from American Chemical Society) (click on image to enlarge) As proof of this concept, a number of antibacterial textiles are investigated, showing high antibacterial activity and good washing durability. Considering that a realm of other functional textiles can be nanofinished, the proposed approach, which is universal and sustainable, can potentially lead to a great number of new applications. Implementing nanotechnology for manufacturing "smart textiles" and developing bio-inspired fibers and fabric coatings represent cutting-edge advancements in the field of textile-based products for a wide range of applications. In conjunction with an aesthetic appreciation of fashion, for instance, fabric aesthetics will expand if their optical appearance is manipulated by utilizing plasmonic nanoparticles. In combination with sensor technologies, color-changing chameleon fabrics will enable adaptation to surroundings, thereby advancing camouflage techniques. What is more, integrating nanoparticles into textiles can also introduce antimicrobial, flame retardant, self-cleaning, and UV protective properties, while simultaneously helping in the development of wearable devices (e-textiles), and exerting chemical softening effects to the textile fibers. Despite this tremendous range of applications, major challenges remain in textile nanofinishing, such as the dispersion, impregnation, distribution, and immobilization of low nanoparticle loads onto textile fibers in a controlled environment, especially when considering the increasing demands for green and sustainable techniques. Such inherent limitations originate from using the traditional pad-dry-cure processes, which are based on the synthesis of colloidal solutions, followed by squeezing out the excess solution from the padded fabrics and drying procedures. These complex procedures raise many major problems: a lack of reproducibility due to batch-type finishing;

release of detrimental wastes; migration of nanoparticles on fibers due to inhomogeneous temperature profile over textiles; limited roll-to-roll speed of the textile finishing line due to inefficient drying; and uncontrolled nanoparticle loading within textiles. The aforementioned shortcomings can be mitigated by employing gas-phase nanoparticle production and subsequently depositing them onto textile fibers. This method for nanoparticle production has been successfully scaled up within the European BOUNAPART-E project and has been described in a just published article in *Journal of Materials Chemistry A* (""Green Manufacturing of Metallic Nanoparticles: a Facile and Universal Approach to Scaling up"). The nanoparticle production in gas phase is fully compatible with commercial roll-to-roll textile manufacturing (see Fig. above), thereby being amenable to upscaling and fulfilling the numerous demands on smart textiles. Another unique feature of this approach to textile nanofinishing lies in that the aerosol nanoparticle deposition allows the manipulation of loading profile within textiles, which is beyond the wet-finishing processes. This feature can be used not only to improve the washing durability of nanofinished textiles, but also to design multifunctional textiles with subsequent nanoparticle deposition of different materials on both sides of textiles. In combination with the controllable sizes and compositions of the nanoparticles produced by spark ablation (read more: *Journal of Materials Chemistry A*: "Green Manufacturing of Metallic Nanoparticles: a Facile and Universal Approach to Scaling up"; *Scientific Reports*: "Toward Industrial Scale Synthesis of Ultrapure Singlet Nanoparticles with Controllable Sizes in a Continuous Gas-phase Process"; and in *The Journal of Physical Chemistry C*: "General Approach to the Evolution of Singlet Nanoparticles from a Rapidly Quenched Point Source"), these features enable expanding new dimensions in research and commodities. *By Jicheng Feng, a former PhD at Delft University of Technology, now a post-doctoral researcher at Leiden University. He initiated and led this work.*

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