Surface modifications with plasma treatment prototype at atmospheric pressure

Stefano Fort [(1)], Maria Rosaria Massafra [(2)], Claudia Riccardi [(3)]

Abstract

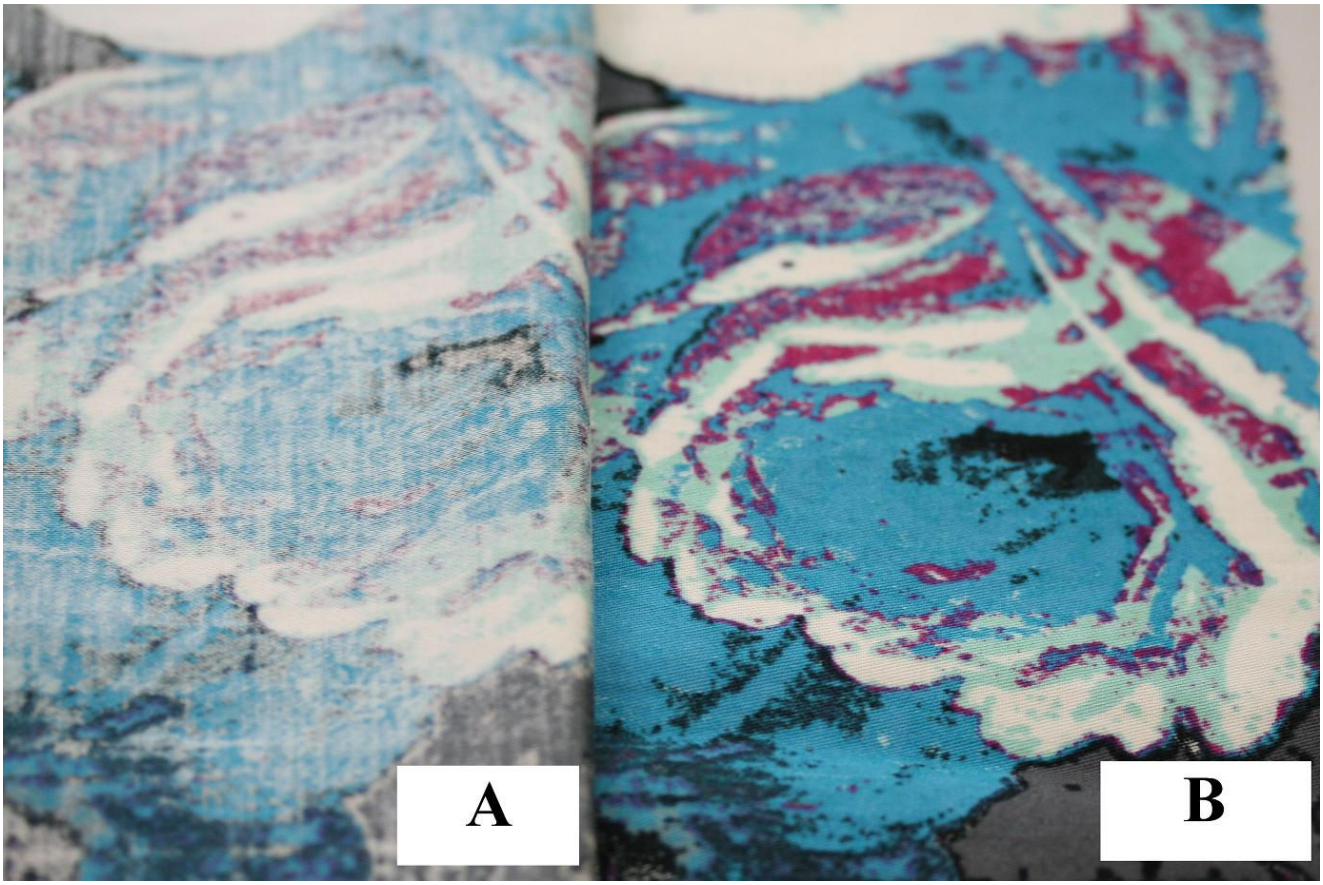


Photo 1: Rear side of a non-treated (A) and treated (B) printed cotton.

Atmospheric plasma is already a reality in textile field. “Technical textiles” and new technologies with low environment impact represent the key for success; properties as hydrophilia, water-repellency, oil-repellency (antistain) are required in such sectors as clothing and furnishing. Plasma treatment represents an opportunity for products diversification and a new technology with low environment impact.

Plasma processes become reality with Arioli industrial prototype, which works at atmospheric pressure; this machine was born thanks to the project “Metadistretti per l'eccellenza lombarda”, titled “*Trattamento al plasma di materiali tessili: sviluppo di un processo e di un impianto per il trattamento al plasma di materiali tessili”*, with “ARIOLI s.p.a.”, textile machinery enterprise, as leader company, together with the research institutes “Stazione Sperimentale per la Seta” and “Plasma Prometeo” of “Università degli Studi – Milano-Bicocca”.

This prototype is based on DBD technology (Dielectric Barrier Discharge): with an electric discharge between two or more electrodes, it is possible to ionize a gas (or a mixture) to

reach the state of plasma for making possible reactions, where radicals, active chemical species and several loaded species are produced. With these it is possible to realize non-conventional surface changing processes, without damages for the bulk fibre.

The processes concern reactions of atoms insertion or complete chemical groups (grafting), generations of free radicals on the surface (activation), polymers deposition in gaseous phase as thin layers adhering to the surface (film deposition) or surface ablation of materials (etching).

This new finishing procedure allows energetic saving (dry processes) and a lower environmental impact (solvents or dangerous chemical products are not required); so it can be defined as " clean technology".

Furthermore, compared with vacuum plasma, it has the advantage to operate at atmospheric pressure, simplifying technological transfer in textile industrial sector where production is realized in continuous way and at relatively high speeds. Process times are considerably reduced and all the disadvantages (roll to roll-seals-pumps) caused by setting of vacuum plants are avoided.

With this machine it is possible to work at different speeds (1-60 m/min) and to make different trials for fabric width up to 2 m.

Several applications are under research with this prototype. In particular chromatic yield in printing and dyeing is ameliorated with plasma treatment. It can be improved from 10 up to 50 %, depending on textile substratum and dyestuff.

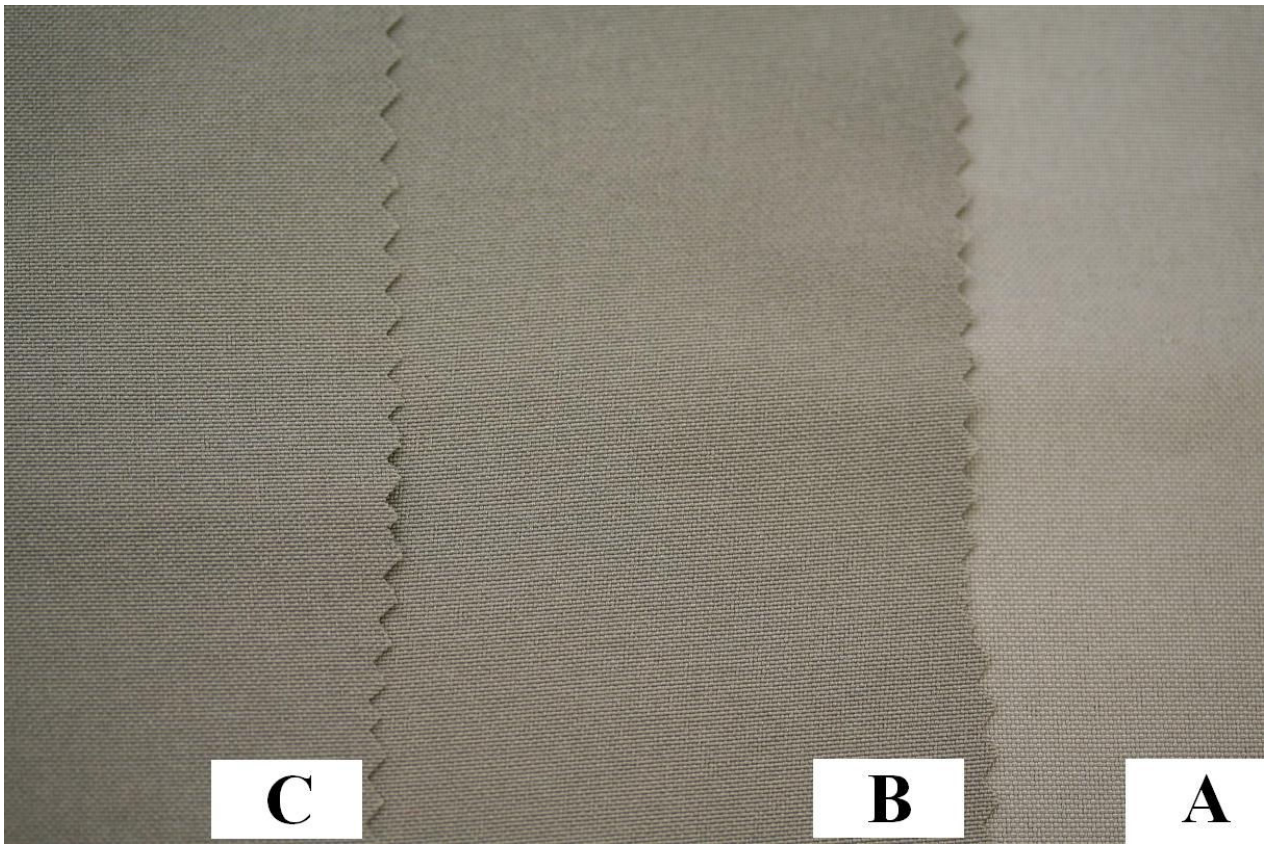


Photo 2: Comparison between dyed polyester (A) and pre-treated with plasma and then

dyed polyester (B, C).

Colour Measure light: D65 Observator: 10°	L*	a*	b*	Delta Eab*
Sample A	49.59	4.15	7.15	Referement
Sample B	43.45	4.14	6.89	6.15
Sample C	43.08	4.21	6.94	6.52

Table 1: Colour measure fo samples in photo 2.

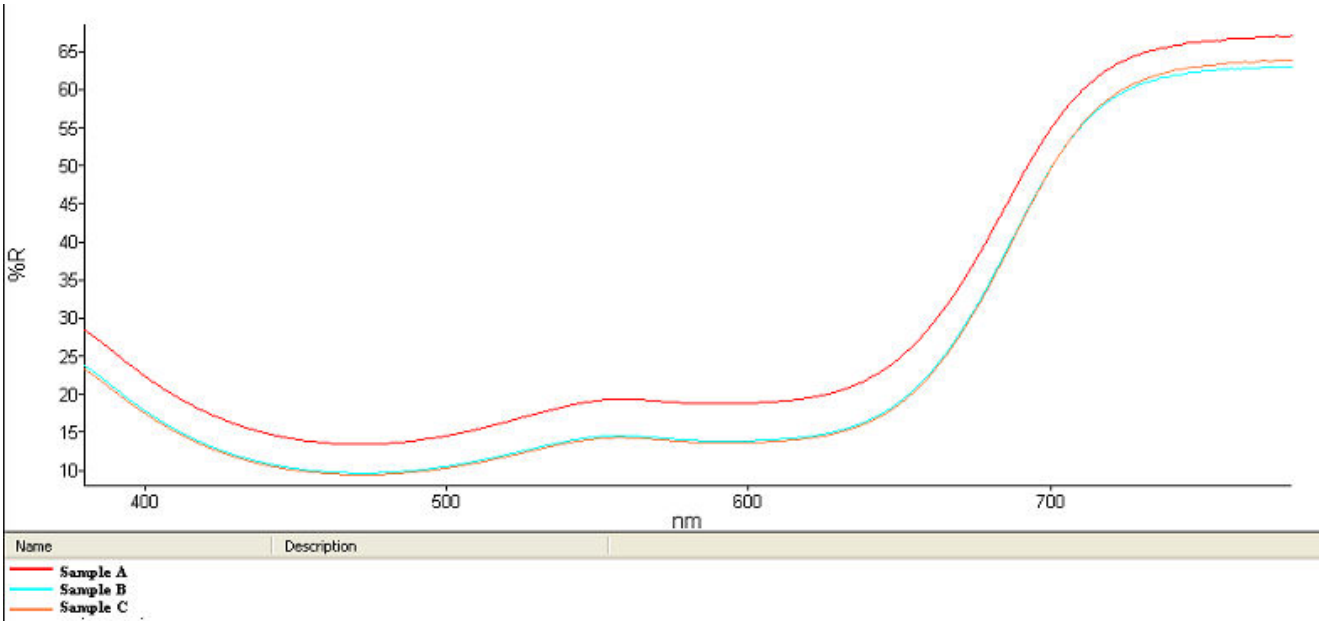
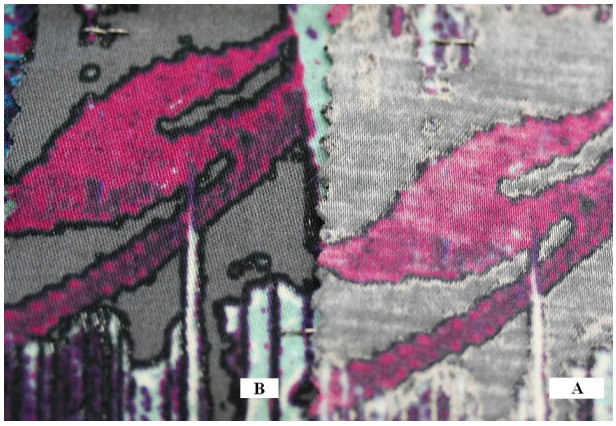
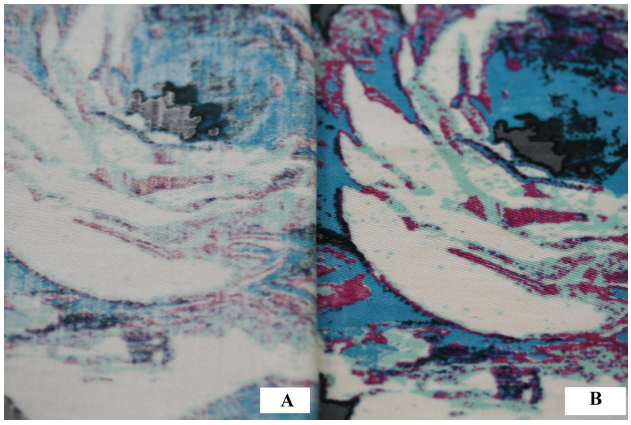


Diagram 1: Reflectance diagram for colour measure of samples in photo 2.

Otherwise dyestuff can be saved, obtaining the same result as in non-treated textiles. The hydrophilic increase and the wettability are very important for polyamide, polyethylene, polypropylene and polyester.

Also cotton, wool and silk have been investigated, because with plasma treatment it's possible to have a better definition of drawing and good colours also on printed textiles rear side (with traditional or digital printing), caused by best absorption and penetration of dyestuffs and inks .





Photos 3, 4: Comparison between rear side of a non-treated (A) and treated (B) printed cotton.

Foulards, scarves, curtains, banners and flags are some applications of this technology.

Other applications are now developing for technical textiles.

Referent	***Company/Institute***	***Address***
[1] Stefano Fort	Arioli s.r.l.	Via G.P. Clerici, 2 21040 GERENZANO (VA) Tel. +39 02-963.99.31 Fax +39 02-963.99.385 info@arioli.biz www.arioli.biz
Graduated in mechanical engineer at "Politecnico di Milano" with a thesis on metal matrix composites (MMC), he has been the manager of the project Metadistretti for Arioli. Now he works on research and development on plasma applied on textiles as R&D chief.		
[2] Maria Rosaria Massafra	Stazione Sperimentale per la Seta	Via G. Colombo, 83 20133 MILANO massafra@ssiseta.it www.ssiseta.it
She works as senior researcher on applications for industrial field, as interface between companies, research institutes (national and international) and laboratories for developing technological programs of innovation. Her interest is on textiles, in particular on silk.		
[3] Claudia Riccardi	PlasmaPrometeo-Università di Milano-Bicocca	Piazza della Scienza, 3 20126 MILANO riccardi@mib.infn.it www.plasmaprometeo.unimib.it
She works on plasma research applied in several fields, team working with several companies and research institutes; the main goal of her activity is research of new technological processes and transfer in technical textiles, paper, packaging, pharmaceutical field, food, health. She is the head of PlasmaPrometeo center of excellence of Lombardy.		