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Endowing Textiles with Permanent Potent Biocidal Properties by Impregnating Them with Copper Oxide

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Copper has been used as a biocide by Celts, Hindus, American pioneers and Japanese, as well as by inhabitants of Africa and Asia for treating sores and skin diseases (1). Today, soluble copper compounds are used as bactericides, algaecides, fungicides or molluscicides. Copper has also been shown to inactivate a variety of enveloped and non-enveloped viruses (2).

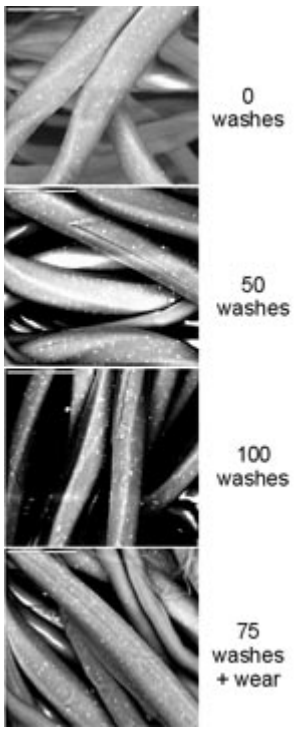

Figure 1. Socks containing 12% copper impregnated fibers were washed up to 100 consecutive times by using AATCC test method (TM) 150. The copper impregnated fibers were analyzed by scanning electronic microscope (SEM). The amount of copper particles throughout the fibers was not changed. Moreover, as shown in the lower SEM picture, there was no reduction in copper oxide particles in socks used and worn 75 times.

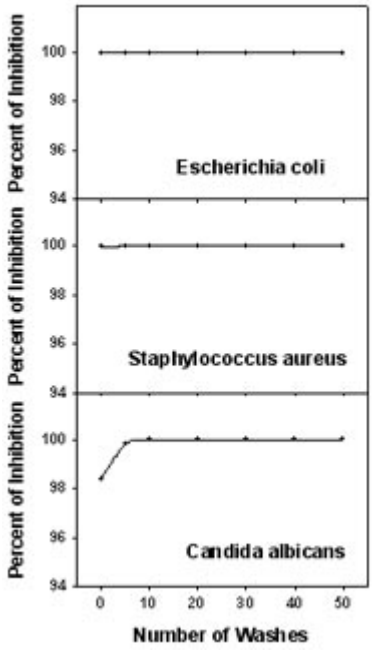

Figure 2. The biocidal efficacy following consecutive washes of a fabric made from a 50/50 polyester/cotton blend. Fifty percent of the polyester fibers were impregnated with 1% (weight/weight) copper oxide particles. The test method used to determine the biocidal efficacy of the fabrics before and after washings was the AATCC TM 100. The tests were conducted by an independent laboratory (AminoLab, Rehovot, Israel). The fabrics were exposed to Staphylococcus aureus and to Escherichia coli for 4 hours and to Candida albicans for 24 hours.

Utilizing the properties of copper, two durable platform technologies were developed: the first one plates cotton fibers with copper oxide and the second one impregnates polyester, polypropylene, polyethylene, polyurethane, polyolefin, or nylon fibers with copper oxide. Both technologies endow the fibers with potent broad-spectrum anti-bacterial, anti-viral, anti-fungal and anti-mite properties (3,4). These copper oxide-treated fibers are then readily introduced into the mass production of woven, knits and non-woven fabrics with no requirement for alteration of industrial procedures or machinery.

a b

Figure 3. a) Antiviral non-woven mask containing 3% copper impregnated polypropylene fibers (w/w). b) Antifungal and antibacterial socks that cure athlete's foot. These socks received the approval of the American Podiatric Medical Association. The soles of the socks contain 12% copper impregnated polyester fibers with 1% (w/w) copper oxide content.

The potency and the kill rate of the fabrics depend on the final percentage and load of the copper oxide plated or impregnated fibers in the fabrics. The biocidal properties of the fabrics are permanent and sustained even following washing and use (Figures 1 and 2). Animal and human studies have demonstrated that these fibers do not possess skin sensitization properties (3,4). This technology thus facilitates the production of anti-viral masks (Fig 3a), gloves and filters (which deactivate HIV-1, flu and other viruses; Ref 3); anti-bacterial fabrics (which kill antibiotic resistant bacteria, including

MRSA and VRE; Ref 3 and 4); anti-fungal socks (which cure athlete's foot; Fig 3b, Ref 4 and manuscript in preparation); anti-dust mite mattress-covers (which reduce mite-related allergies; Ref 3) and gauze (which is highly effective in promoting skin regeneration, closure of chronic wounds and the alleviation of bed sores; manuscript in preparation).

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