

**NOVEL APPLICATIONS OF COPPER OXIDE IN
MEDICINE: FROM PREVENTING INFECTION
TO WOUND HEALING**

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In contrast to the low sensitivity of human tissue to copper, micro-organisms are extremely susceptible to copper. Thus, copper ions have been used for centuries to disinfect fluids, solids and tissues (1). Today copper is used as a water purifier, algacide, fungicide, nematocide, and as an anti-bacterial agent.

A platform technology has been developed in which copper oxide is plated onto or impregnated into cotton fibres or polymeric fibres, respectively (Fig 1).

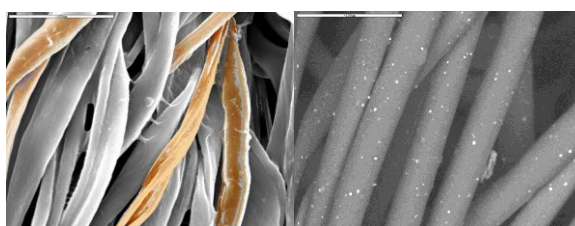


Figure 1. SEM images of cellulose fibres plated with copper oxide (left panel) and polyester fibres containing copper oxide particles (right panel)

Copper oxide containing fibres demonstrate potent broad-spectrum anti-bacterial, anti-fungal, anti-viral, and anti-mite properties [1-3]. Copper oxide-treated

fibres are used for mass production of woven and non-woven biocidal fabrics [1,2].

Possible Medical Applications

1. Anti-bacterial self-sterilizing fabrics and nosocomial infections. Nosocomial infections rates, especially those caused by antibiotic resistant bacteria, are increasing alarmingly worldwide. Textiles are an excellent substrate for bacterial growth under appropriate conditions. The temperature and humidity between the patients and the bed are appropriate conditions allowing for effective proliferation of bacteria shed by patients. Contaminated textiles in hospitals can thus be an important source of microbes contributing to endogenous, indirect-contact, and aerosol transmission of nosocomial related pathogens [4]. The use of antimicrobial textiles, especially in those textiles that are in close contact with the patients, may significantly reduce bioburden in clinical settings and consequently reduce the risk of nosocomial infections [4].

2. Anti-dust mite mattress-covers and allergies. Dust mite faeces are an important source of allergens. Human skin scales that have been shed, and that have been pre-digested by fungi, are the main food source

for these organisms that thrive in bedding, sofas and carpets. Copper oxide containing cellulosic and polymeric fabrics possess broad-spectrum anti-microbial and anti-fungal properties (Fig 2).

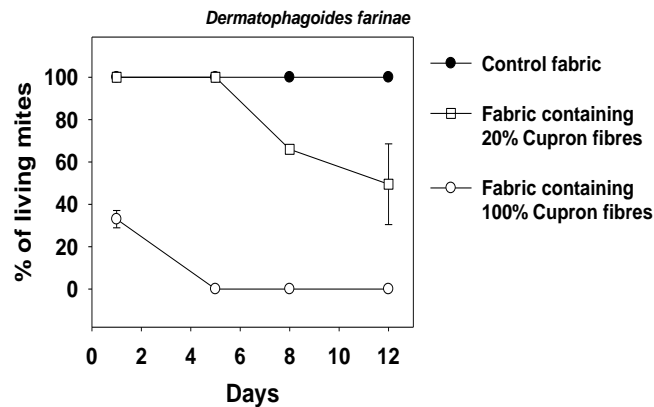


Figure 2. Anti-mite activity of fabrics containing 0.4 and 2% copper oxide (w/w)

The usage of fabrics containing copper oxide may thus be an important avenue for killing the house dust mite and reducing the load of dust mite allergens.

3. Anti-viral filters, blood banks and breast feeding. Copper oxide-containing filters reduce infectious titers of a panel of viruses spiked into culture media. Enveloped, non-enveloped, RNA and DNA viruses were affected, suggesting the possibility of using copper oxide-containing devices to deactivate a wide spectrum of infectious viruses found in filterable suspensions, such as virus contaminated blood, plasma and breast milk [3].

4. Anti-fungal Socks and Athlete's Foot.

Athlete's foot (*tinea pedis*) is a common fungal infection of the feet. Fifty-six individuals with *tinea pedis* were given socks containing copper oxide. They wore the socks daily and did not receive any anti-fungal treatment. Statistically significant improvement or resolution of erythema, burning and itching, oedema, scaling, vesicular eruptions and fissuring occurred in an average follow up of 9 days (Fig 3).

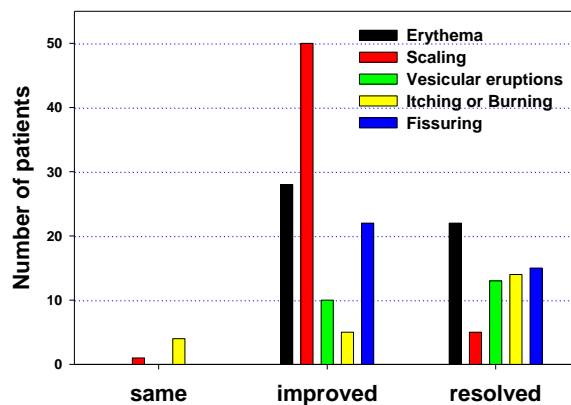


Figure 3. Treatment of Athlete's Foot with Socks Containing Copper Oxide Impregnated Fibres

None of the study subjects worsened or showed adverse reactions while wearing copper oxide impregnated socks. This study strongly supports the effectiveness in using copper oxide impregnated fibers in treating the common manifestations of athlete's foot.

4. Wound Dressings and Diabetic Ulcers. Copper

is a key player in wound repair. Copper stimulates the

formation of new capillaries via induction of vascular endothelial growth factor (VEGF), copper stabilizes fibrinogen and collagen and copper modulates integrins expressed during the final wound healing phase [5].

The potent biocidal activities of copper, the very low risk of adverse skin reactions associated with copper and its roles in the wound healing process, represent significant cumulative benefits, as a result of which we hypothesized that application of copper containing wound dressings to wounds may significantly enhance healing [5]. Indeed, in two experiments with diabetic mice, in which a full-thickness 6-mm circular single wound was created on the dorsum of diabetic mice (n=15) and then continuously covered with either Cupron or Control pads, the copper oxide containing wound dressings significantly reduced the time of wound closure (Fig 4).

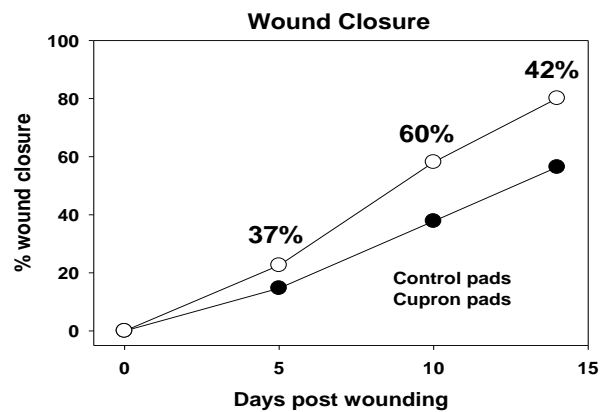


Figure 4

Similar results were obtained in 12 patients with chronic ulcers who responded poorly to conventional treatments. One such example is shown in Figure 5.



Figure 5. Healing of ulcer in the foot of a 71 years old diabetic patient. The wound did not close even when treated for 9 months by conventional treatment

In conclusion, this paper presents potential uses of copper in applications that address medical concerns of the greatest importance.

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