

Nickel release from white gold

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Nickel is still the most frequent cause of contact allergy, despite the EU regulation limiting nickel release from consumer items intended for prolonged contact with the skin, such as jewellery, buttons, and watches. It is obvious that the current restriction is insufficient (1). It has been shown that nickel is deposited onto the skin by short and repetitive contact in amounts sufficient to cause nickel

dermatitis (2–4). The European Chemicals Agency has the task to present a definition of “prolonged contact with skin” in relation to the nickel restriction, for more efficient prevention of nickel allergy.

A patch test study with 21 nickel-containing materials was performed when EN 1811, the reference test method for control of compliance with the regulation, was developed (5). Among 100 nickel-allergic subjects, 17% reacted to a white gold alloy with nickel release of $0.4 \pm 0.2 \mu\text{g}/\text{cm}^2/\text{week}$. This white gold is the quality control material in EN 1811:2011 (6). Nickel release from other materials containing nickel as an alloying element, for other functions or as an impurity, has been studied by immersion in artificial sweat for minutes, hours, and weeks (7–10). The nickel release rate from

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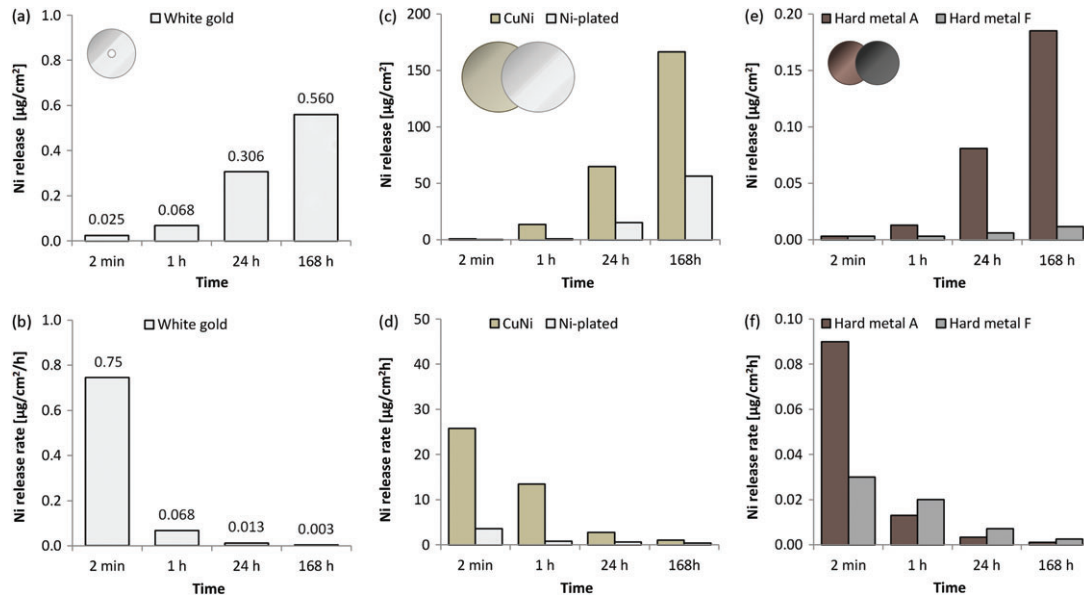


Fig. 1. Nickel release in artificial sweat (EN 1811:2011) from nickel-containing materials: white gold discs (a, b); UK 5p CuNi and nickel-plated coins (c, d) (10); and hard-metal materials with trace amounts of nickel (e, f) (9). Time-dependent nickel release (a, c, e), and the same data recalculated as release rate per hour (b, d, f). Triplicate sets were analysed in all cases, except for duplicates for the hard metals at 168 hr.

these materials (copper–nickel, nickel-plated steel, and nickel as an impurity in hard metals) was initially very high, and then declined rapidly. The purpose of the present study was to investigate nickel release and nickel release rates from the white gold alloy at different time points.

White gold discs 18K (Au 75.89%, Cu 16.01%, Ni 6.00%, Zn 2.10%; surface area 2.42 cm²/disc), the quality control material in EN 1811:2011, were purchased from Allgemeine Gold und Silberscheideanstalt AG, Pforzheim, Germany. The discs were gently abraded with wet emery paper (SiC; 600 followed by 1200), rinsed with deionized water, degreased in 0.5% sodium dodecyl benzene sulfate solution (2 min), rinsed again until there was no foaming, gently dried with paper tissue, and placed on paper tissue to dry overnight. All glass and plastic utensils were acid-cleaned in 10% HNO₃ prior to use.

Artificial sweat (0.5% NaCl, 0.1% urea, 0.1% lactic acid, and deionized water, pH 6.5) was prepared the next day according to EN 1811:2011. The bottoms of 60-ml flasks were covered with glass beads, and two white gold discs were placed in each flask. Five millilitres of artificial sweat solution (surface area/volume ratio of ~1) was added to the flasks, and triplicate sets of discs and one blank were immersed for 2 min, 1 hr (solution preheated to 30°C), 24 hr and 1 week at 30°C in a heating cabinet. After the immersion period, discs were removed; the artificial sweat solution was transferred to a new tube (25 ml), acidified with 85 µl of 65% HNO₃, and stored in a refrigerator until analysis. Chemical analysis

was performed with inductively coupled plasma-mass spectrometry (X Series II; Thermo Scientific, Waltham, MA, USA). The limit of detection was 0.10 µg/l for nickel.

The accumulation with time of released nickel and the variation in nickel release rate for the white gold discs in artificial sweat are shown in Fig. 1a,b. The amount of nickel released in 1 week was 0.56 µg nickel/cm². Results obtained in previous studies with cupro-nickel coins, nickel-plated coins and two hard-metal materials are shown for comparison (Fig. 1c–f) (9, 10). The rate of nickel release (release rate per hour) from all tested materials, including the white gold alloy, was highest in the first couple of minutes, and then declined rapidly.

The pattern of nickel release, with an instant and initially relatively high nickel release rate, is important for understanding why nickel can be deposited onto the skin and cause hand eczema by short and repetitive contact. This release pattern is also seen for the white gold alloy used as the quality control material in EN 1811:2011.

The amount of nickel on the skin is decisive for the allergy risk. Nickel that is available for ionization on skin contact is deposited onto the skin by every single touch, and thus contributes to the amount of nickel accumulated from different contacts. Coins, computers, eyelash curlers, handles, keys, needles, pens, scissors, taps, tools, toys and utensils are often made of nickel-plated or other nickel-releasing materials. They are well-known examples of items causing nickel dermatitis, despite the fact that they generally come into very short and repetitive

contact with the skin. This was not considered when the nickel regulation was introduced, but it needs to be taken into account for efficient prevention of nickel allergy and dermatitis.

We suggest that the most pragmatic approach for the nickel restriction would be that items with a positive

dimethylglyoxime test result should not be intended for skin contact. This is based on knowledge about nickel release from materials and deposition of nickel onto skin. It is also generally recommended by dermatologists to nickel-allergic patients.

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