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Different forms of pulmonary diseases have been described among workers exposed to hard metals. Hard metal are made of a mixture of tungsten carbide particles cemented in cobalt metal powder. Workers exposed to hard metal dusts can develop some pulmonary diseases such as asthma and a form of interstitial fibrosis known as "hard metal lung disease".

The exposure to hard metal is also related to an increased risk of lung cancer. Recently IARC (International Agency for Research on Cancer) classified Co/WC as "probably carcinogenic to humans" (group 2A), while Co alone was classified as "possibly carcinogenic to humans" (group 2B) (IARC, 2006).

The mechanisms involved in Co/WC toxicity are only partially known. It was hypothesized that when Co an WC are in contact, a specific reaction would take place and a large amount of reactive Oxygen Species (ROS) would be released causing oxidative stress to cells and tissues. The mechanism hypothesized for the generation of ROS involves the translocation of electrons from cobalt to the WC surface and the simultaneous reduction of oxygen dissolved in water to superoxide-like species, alongside the release of Co^{2+} ions into solution.

The inhaled particles interact with the lung lining layer made up of surfactant, proteins and rich in glutathione (GSH) and ascorbic acid. GSH and ascorbic acid may be oxidised, by free radical and metal ions, to glutathione disulfide (GSSG) or other mixed disulfides, and to dehydroascorbic acid, respectively. In virtue of this reactivity GSH and ascorbic acid have an important antioxidant activity and protect cells and tissues towards the oxidative damage. Antioxidant depletion may contribute to the toxic potential of hard metal dusts, since a depletion of such antioxidant defences would increase the effects caused by ROS generated by inhaled particles.

Through the identification of superoxide radical (ESR/spin trapping) and the electrochemical study of the interaction between Co and WC particles, we contributed to clarify the chemical mechanism at the basis of Co/WC reactivity. Moreover we studied the interaction between Co/WC and the endogenous antioxidants, the consumption of which can play a key role in the toxicity mediated by ROS. Aim of the experimental work was the study of the reactivity as a mean to predict the toxicity of some inorganic dusts. In particular we studied the involvement of superoxide in the reactivity of Co/WC mixture.

Since the peculiar reactivity acquired by Co in association with WC would be responsible for the toxicity of hard metals, it was hypothesized that the substitution of Co with another metal matrix could produce hard metals characterized by a lower toxicity than those containing Co. At the Department of Chemical Engineering and Materials Science of Polytechnics of Torino Ti-Cu and Al-Ti-Cu mixtures, two possible substitute of Co, are studied in term of mechanical and technological properties Aim of the experimental work described herein was the study of the reactivity of Ti-Cu and Al-Ti-Cu mixtures (alone and in association with WC) in order to predict their potential toxicity. By means of ESR/spin trapping technique we investigated the reactivity of the these dusts toward C-H bond in the organic molecules and the Fenton activity in the

presence of H_2O_2. The data were compared to those obtained with Co, alone mixed with WC. We also studied the reactivity of ITO (indium tin oxide), a dust of increasing toxicological interest. This material, which is widely employed in the industrial production of LCD screens and other electronic devices, is involved in some cases of pulmonary toxicity.
H.C. Starck (Goslar, Germany) produced some alternative hard metals which could be less toxic than those currently used. Herein we describe a study carried out on the reactivity of these dusts in order to predict their potential toxicity.
Some of the samples tested have a Co/WC composition, but are prepared thorough an alternative industrial process which may influence their reactivity. Some others are dusts where the Co is partially or completely substituted with other metals such as Ni, Cr, Fe, Al.
For some of these metals IARC (International Agency for Research on Cancer) evaluated the carcinogenic risk to human.
In 1997 Ni (II) was classified as carcinogenic to humans (class 1), whereas Ni metal was classified only as possibly carcinogenic (class 2B). Ni metal in association with W and Co is employed for the production of an alloy of industrial interest. Recently both in vitro and in vivo studies reported that the association of these metals is responsible for an extremely high carcinogenicity and genotoxicity.
Chromium (VI) was classified by IARC as carcinogenic to humans (class 1), whereas Cr (III) and Cr metal was not classified as carcinogenic (class 3) (IARC, 1990).
The lung toxicity of Al is controversial. Despite the widespread employment of this metal in industrial field, only a limited number of cases of fibrosis among the workers exposed is reported. Exposure to iron oxide is related to siderosis. Siderosis is generally assumed to be a benign condition and clynical symptoms are usually minimal or nonexistent : the chest radiographs can evidence some lung modifications which disappear when the exposure ceases.
Aim of the experimental work described herein was the study of industrial hard metals reactivity in terms of free radical release. By means of the ESR/spin trapping technique we evaluated the capability of the samples (i) to produce $COO^{\bullet -}$ radicals through the rupture of C-H bond in the formate ion as a first step of damage towards the biomolecules and (ii) to reduce oxygen to superoxide radical, which may rapresent the first step of ROS production.
Some metals can exert a toxic effect when in contact with biological fluids. Such toxicity is generally mediated by metal ions released in solution. The reaction is electrochemical in nature and it is the metal ions, formed by anodic reaction, that exert the toxic behaviour. Electrons from the anodic reaction are consumed by the corresponding cathodic reaction, most commonly, reduction of oxygen. Ion release from a metal is strictly influenced by its redox potential, the insoluble salts precipitation and the formation of passivation layers that prevent corrosion. Also the quantity, the composition and the electric conductivity of the biologic fluid in contact with the metal plays an important role in ion release.
The ion release from an alloy is a more complex event than the release from a pure metal. Being a consequence of an electrochemical reaction, it is effected by the redox potentials of all the metallic components.
One of the consequences of metal ion toxicity is Allergic Contact Dermatitis (ACD) . Metal ions such as nickel (II), cobalt (II), copper (II), chromium (III), palladium (I) and platinum (I) can induce allergic reactions. Due to their small size, metal ions are incomplete antigens (haptens) which have to bind to endogenous peptides to become full antigens able to induce a specific T-cell response. Nickel allergy is the most frequent contact allergy in industrialized parts of the world. The EU Nickel Directive, aiming at primary and secondary prevention of nickel allergy

states that the limit of nickel release from products intended to be in direct and prolonged contact with the skin must be less than 0.5 g/cm^2/week (European Directive, 94/27/EEC, 1994). A standard procedure for demonstrating the compliance to the European directive is based on the measurement of Ni ions concentration determined after a 1 week incubation in an artificial sweat solution (UNI EN 1811, 1998).
Besides nickel, also Co and Cr are considered important sensitizers.
Even though allergy towards Au salts is well documented, the allergenic potential of metal gold is controversial as the scanty ion release, depending upon the chemical inertness of this metal, reduces the bioavailability of the ions necessary to elicit the allergic reaction.
ACD is observed also after exposure to soluble Pd and Pt salts. Also in this case, the chemical inertness of this metals in their elemental state agrees with their limited importance as sensitizers.
Despite the lack of data, Cu is acquiring an increasing importance as allergen. Even though it exhibits an allergenic potential lower than other metals, some authors evidenced that allergy to copper, usually associated to allergy to Ni, have a certain clinical relevance.
Herein we investigated the behaviour of some amorphous alloys when in contact with the artificial sweat solution. The aim of the present study was to predict the allergenic potential of such alloys measuring the allergenic ions release by means of ICP/AES technique. In order to identify preferential corrosion sites, the surface of the alloys was studied by means of SEM technique.