Hardmetal workplaces: Measurement, analysis and distribution of exposures

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Background

Hardmetal represents an important class of industrial materials that exhibit a high degree of hardness and resistance to abrasive wear. Hardmetal refers to a composite consisting of tungsten carbide with a ductile metal binder (typically cobalt, about 15 to 20% by volume). As with any material, uncontrolled industrial exposures may give rise to adverse effects on employees' health. There are indications that working at hardmetal workplaces can endanger human health. Assessment of potential effects on employees' health in the hardmetal industry is complicated by the wide range of product formulations that include a variety of auxiliary metals and metal carbides. Limited data is currently available regarding overall metal exposures within the hardmetal industry in Germany.

The first step of this project was to develop an analytical method for hardmetals that should be simple, fast and sensitive and delivers a maximum of information on the dust composition. In the next step inside the Measurement System for Exposure Assessment of the German Social Accident Insurance Institutions – MGU (formerly BGMG) a measurement program "exposures in hardmetal workplaces" has been carried out since early 2007. All exposure values are documented in the IFA exposure database MEGA for statistical analysis.

Results

1. Analysis

Besides ICP-OES[1] and ICP-MS[2] for the analysis of the samples another method, TXRF - Total reflection X-ray Fluorescence Spectrometry, was used (Table 1). This method allows a special, very simple sample preparation. So it is possible to renounce complex digestion procedures before analysis. The samples can be measured as suspensions which are embedded in a matrix with internal standards.
[1] ICP-OES - Inductively Coupled Plasma Optical Emission Spectrometry
[2] ICP-MS - Inductively Coupled Plasma Mass Spectrometry.

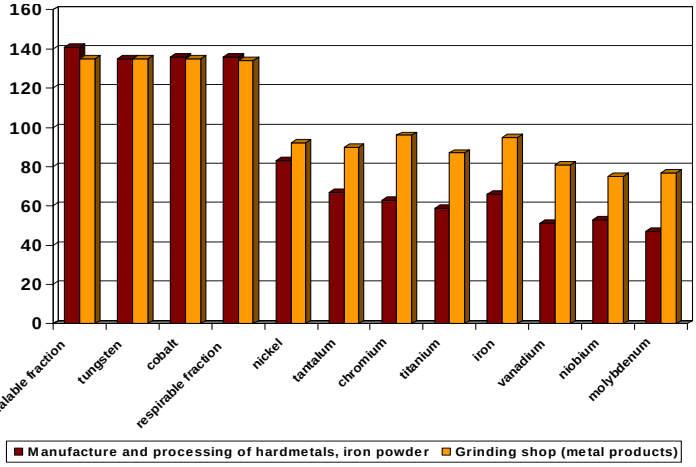
Table 1: Detection limits of different analytical methods for cobalt and tungsten

Metal	Sample collection system	Sample holder type	Air volume in m³	TXRF Suspen-sion	TXRF*	ICP-OES*	ICP-MS*
				in µg/m³			
Co	PAS-pump, GSP-10	MF11301 37 mm	1.2	0.8	1.3	3.4	0.8
W	PAS-pump, GSP-10	MF11301 37 mm	1.2	4.2	4.8	17	1.7
				* analysis after microwave assisted digestion			

2. Measurement Program

Representative workplace measurements are made using personal IFA standard methods, as well as stationary measurements when necessary, which allow valid exposure estimates. Between 2007 and 2009 measurements were made in 52 companies. All about approximately 2,500 measurement values were determined (Figure 1).

Figure 1: Number of measurements per compound



3. Distribution of Exposure

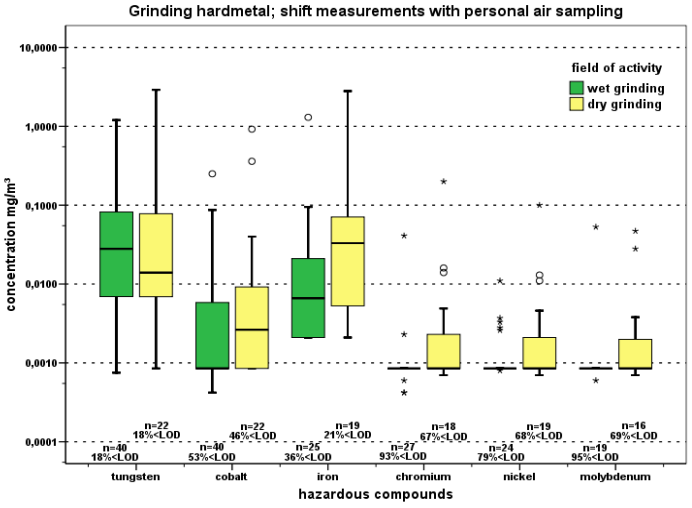
Measurements are made in several fields of activities, such as manual weighing of metal powder mixtures, pressing or sintering. The focus of this poster deals with the comparison between wet and dry grinding. 1,622 analysis were made for several metals during wet or dry grinding (Table 2).

Table 2: Number of measurements for wet and dry grinding

Working areas within the processing of hardmetals	Number of measurements
Wet grinding	**1062**
Dry grinding	**560**
Analysis over all	**1,622**

The statistical evaluation was made on shift related personal measure-ments. Most of these measurements were carried out in working areas with local exhaust ventilation. Whether wet or dry grinding, analysis of titanium, vanadium, niobium and tantalum are below LOD (Limit of Detection) in more than 93% of the measurements.

Figure 2: Distribution of the measurement values for wet and dry grinding



Except tungsten, concentrations found on wet grinding are lower than those on dry grinding (Figure 2). Especially measurements on chromium, nickel and molybdenum are in most cases below the LOD during wet grinding.

Discussion

Approximately 2,500 analytical data points have been measured and have been evaluated. For the first time besides cobalt and tungsten an extensive investigation of exposure in hardmetal workplaces have been carried out. In mainly cases the state of the art of the working conditions is quite fulfilled. The assessments of these exposure data will be available for interested associations developing exposure scenarios in the context of REACH. It is expected that the data will be valuable in understanding contemporary exposures in the hardmetal industry and will provide insight into the effectiveness of current control measures used by the industry.