**Supplementary tables**

**Supplementary Table 1.** Alloy composition of filler materials (information on flux composition for filler materials of F1-F6 not available) in wt-%, based on supplier information.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Filler material** | **Cr** | **Ni** | **Mn** | **Si** | **Mo** | **Others** |
| **308L**  **(S1, F1, F2)** | 19-20 | 10 | 1.2-1.8 | 0.7-0.8 | 0.1 | C<0.03, P 0.015, S 0.015, Cu 0.1 |
| **UNS S32101**  **(M2, F3-F6)** | 21-23 | 8-10 | 0.5-1 | 0.5-0.9 | 2.8-3.3 | N 0.11-0.17, C<0.03, P<0.03, S<0.025 |

**Supplementary Table 2a**. Elemental composition in wt-% of fume particles S1, F1-F6, based on EDS, C-content excluded. Data shows the average and standard deviation of 4-11 individual spectra.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ID** | **O** | **F** | **Na** | **K** | **Mg** | **Fe** | **Cr** |
| **S1** | 45±17 | <LOD | 0.11±0.17 | <LOD | 1.8±3.6 | 29±23 | 10±4.9 |
| **F1** | 40±5.3 | 13±3.9 | 9.4±4.8 | 6.3±4.1 | <LOD | 5.1±3.4 | 3.7±1.9 |
| **F2** | 48±2.7 | 11±10 | 6.9±8.0 | 5.2±6.1 | <LOD | <LOD | 1.4±2.7 |
| **F3** | 41±11 | 13±7.0 | 8.9±6.3 | 6.8±4.4 | <LOD | 5.7±5.4 | 10±15 |
| **F4** | 42±12 | 15±12 | 13±8.2 | <LOD | <LOD | 1.5±2.8 | 5.6±3.5 |
| **F5** | 46±12 | 19±17 | 27±18 | 0.44±0.98 | <LOD | <LOD | <LOD |
| **F6** | 44±9.0 | 17±12 | 14±9.1 | 0.47±0.49 | <LOD | 2.4±2.4 | 4.9±5.1 |

**Supplementary Table 2b**. Elemental composition in wt-% of fume particles S1, F1-F6, based on EDS, C-content excluded. Data shows the average and standard deviation of 4-11 individual spectra.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **ID** | **Mn** | **Ni** | **Ti** | **Zr** | **Al** | **Si** | **Zn** |
| **S1** | 7.2±4.8 | 3.4±3.5 | <LOD | <LOD | <LOD | 2.6±3.9 | 0.3±0.5 |
| **F1** | 4.7±3.1 | 0.30±0.36 | 9.3±17 | 1.9±3.7 | 1.4±1.4 | 3.4±2.2 | <LOD |
| **F2** | <LOD | <LOD | 18±21 | 3.7±4.3 | 2.8±1.3 | 4.1±5.1 | <LOD |
| **F3** | 3.8±5.1 | <LOD | 7.6±11 | <LOD | 0.38±0.49 | 2.3±2.9 | <LOD |
| **F4** | 4.6±2.5 | <LOD | 16±24 | <LOD | <LOD | 2.5±1.7 | <LOD |
| **F5** | <LOD | <LOD | <LOD | <LOD | <LOD | 7.5±7.8 | <LOD |
| **F6** | 3.7±4.1 | <LOD | 12±19 | <LOD | <LOD | 2.0±1.7 | <LOD |

**Supplementary Table 2c**. Elemental composition in wt-% of fume particles S1, F1-F6, based on EDS, C-content excluded. Data shows the average and standard deviation of 4-11 individual spectra.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **S** | **Bi** | **Pb** | **Mo** |
| **S1** | 0.060±0.10 | <LOD | <LOD | <LOD |
| **F1** | 0.060±0.12 | 0.66±0.86 | 0.18±0.36 | <LOD |
| **F2** | <LOD | <LOD | <LOD | <LOD |
| **F3** | 0.15±0.19 | 0.19±0.64 | <LOD | 0.060±0.20 |
| **F4** | <LOD | <LOD | <LOD | <LOD |
| **F5** | <LOD | <LOD | <LOD | <LOD |
| **F6** | <LOD | <LOD | <LOD | <LOD |

**Supplementary Table 3**. Average release (n=3) of Cr(VI), Cr(III), Mn, and Fe in PBS after 24 h at 37 °C expressed as the percentage of the total corresponding metal content of the fume particles (after digestion) from two different welding occasions.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Sample name** | **Base/filler metal** | **Shielding gas/melting rate** | **Metal release of total metal (%wt)**  **Cr(VI) of Cr Cr (III) of Cr Mn Fe** | | | |
|  |  |  |  |  |  |  |
| F1 | 304L, FCW 308L | Ar, 18% CO2, 0.03% NO, High | 55; 68 | 17; 5 | 15; 14 | <LOD; 0.4 |
| F2 | 304L, FCW 308L | Ar, 18% CO2,High | 56; 62 | 4.8; <LOD | 12; 12 | 0.2; 0.2 |
| F3 | UNS S32101, FCW UNS S32101 | Ar, 18% CO2, 0.03% NO, High | 68; 83 | 15; <LOD | 8.8; 7.2 | 0.6; <LOD |
| F4 | UNS S32101, FCW UNS S32101 | Ar, 18% CO2, High | 77; 57 | 15; <LOD | 9.1; 6.1 | 1.3; <LOD |
| F5 | UNS S32101, FCW UNS S32101 | Ar, 18% CO2, 0.03% NO, Low | 83; 67 | 15; <LOD | 35; 26 | <LOD; 0.6 |
| F6 | UNS S32101, FCW UNS S32101 | Ar, 18% CO2, Low | 69; 55**e** | <LOD; <LOD | 33; 22 | 2.1; <LOD |

**Supplementary Table 4.** Probability (p) values of differences between different groups of welding fumes and for different released metals into PBS (24 h, 37 °C). p-values smaller than 0.05 are considered as a statistically significant difference. Statistical analysis is based on a student's t-test of unpaired data with unequal variance (KaleidaGraph version 4.0).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Difference between** | **Difference in** | **Cr(VI)** | **Cr(III)** | **Mn** | **Fe** |
| F1-F2 | shielding gas | 0,8 | 0,39 | 0,17 | ≈1 |
| F3-F4 | 0,58 | ≈1 | 0,84 | 0,69 |
| F5-F6 | 0,35 | 0,5 | 0,72 | 0,6 |
| (F1;F2,F3;F4)-(F5;F6) | melting rate (arc mode) | 0,72 | 0,49 | **0,0058** | 0,56 |

**Supplementary Table 5.** Present occupational exposure limits (OELs) in Sweden and the European Union (Swedish Work Environment Authority, 2018). Most OELs are available as average values for an 8 h working day. For Cr(VI), a short term OEL is defined as an average value during 15 min. Since the welding fume particles in this study are mainly smaller than 4 µm, they are equal to the respirable fraction. Some OELs shown in the table are defined for the total dust mass, and some for the respirable fraction, in this study the same.

|  |  |  |
| --- | --- | --- |
|  | **OEL working day (µg/m³)** | **OEL short term (µg/m³)** |
| **Chromium(VI)** | 5 | 15 |
| **Iron oxides** | 3500 | - |
| **Manganese** | 50 | - |
| **Nickel** | 500 | - |
| **Fluorides** | 2000 | - |

Swedish Work Environment Authority, Exposure limit values (AFS 2018:1), regulations, https://www.av.se/arbetsmiljoarbete-och-inspektioner/publikationer/foreskrifter/hygieniska-gransvarden-afs-20181-foreskrifter/, accessed 2019-02-13. (in Swedish)

**Supplementary Figures**

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**Supplementary Figure 1**. Correlation between metal release and toxicity. The upper figure shows linear regression between the Mn release in PBS and cytoxicity observed after exposure to 50 µg/mL of welding fume particles for 24 h. The lower figure shows the correlation between Cr(VI) release in PBS and induction of acellular ROS assessed by DCFH-DA.