**Electrochemical and Raman analysis of the corrosion products formed over hot dip galvanized steel wires exposed in different environmental sites**

Gopal Jia,c\*, Kitty Barta, Bart Allaertb, Annick Hubina and Herman Terryna

aDepartment of Materials and Chemistry, Research Group of Electrochemical and Surface Engineering, Vrije Universiteit Brussel, Pleinlaan 2, 1050, Brussels Belgium

bElectrochemical and Corrosion Lab, NV Bekaert SA, Oude Heerweg 5, 8540, Deerlijk, Belgium

cCentre for advanced studies, APJAKTU Lucknow, U.P. -226031, India

\*Corresponding author: email, [gopal.ji@vub.ac.be](mailto:gopal.ji@vub.ac.be), [gopal.ji.ji@gmail.com](mailto:gopal.ji.ji@gmail.com)

**List of Figures and Tables:**

**Figure S1.** Raman spectrum of ZnO detected on pristine wire.

**Figure S2.** Raman spectra of zinc oxide, zinc carbonate and hydrozincite detected on aged wires.

**Figure S3.** Raman spectra of zinc hydroxy chloride (Simonkolleite), zinc hydroxy sulpahte and hydrated namuwite detected on aged wires.

**Figure S4.** Raman spectra of mixed zinc (sulphates-carbonates-OH bonds) detected on aged wires.

**Figure S5.** Fitting results for (a) aged Belgium wires and (b) aged Indonesia wires in 0.1 M NaCl and 0.1 M Na2SO4.

**Figure S6.** Comparison of corrosion rates of the wires based on polarization resistance.

**Table S1.** Peak assignments for various corrosion products of zinc.

**Table S2.** Ba and Bc values for pristine and aged wires in 0.1 M NaCl and 0.1 M Na2SO4.

**F:\1_2018_all_work_smst\Atmospheric_corrosion_Brussels\manuscript\Figure_S1.tif**

**Figure S1. Raman spectrum of ZnO detected on pristine wire.**

**F:\1_2018_all_work_smst\Atmospheric_corrosion_Brussels\manuscript\Figure_S2.tif**

**Figure S2. Raman spectra of zinc oxide, zinc carbonate and hydrozincite detected on aged wires.**

F:\1_2018_all_work_smst\Atmospheric_corrosion_Brussels\manuscript\Figure_S3.tif

**Figure S3. Raman spectra of zinc hydroxy chloride (Simonkolleite), zinc hydroxy sulpahte and hydrated namuwite detected on aged wires.**

**F:\1_2018_all_work_smst\Atmospheric_corrosion_Brussels\manuscript\Figure_S4.tif**

**Figure S4. Raman spectra of mixed zinc (sulphates-carbonates-OH bonds) detected on aged wires.**

**F:\1_2018_all_work_smst\Atmospheric_corrosion_Brussels\manuscript\Figure_S5.tif**

**F:\1_2018_all_work_smst\Atmospheric_corrosion_Brussels\manuscript\Figures_all_used_manuscript\Figure_S6_new.tifFigure S5. Fitting results for (a) aged Belgium wires and (b) aged Indonesia wires in 0.1 M NaCl and 0.1 M Na2SO4.**

**Figure S6. Comparison of corrosion rates of the wires based on polarization resistance.**

**Table S1. Peak assignments for various corrosion products of zinc.**

|  |  |  |
| --- | --- | --- |
| **Compounds** | **Chemical Name** | **Main peaks (cm-1)** |
| ZnO | Zincite/Zinc oxide | 560 |
| ZnCO3 | Zinc carbonate | 1100 |
| Zn5(OH)6(CO3).2H2O | Hydrozincite | 1060 |
| ZnSO4.3Zn(OH)2 | Zinc hydroxy sulphate | 960 |
| ZnSO4.3Zn(OH)2.nH2O, n=3-5 | Hydrated zinc hydroxy sulphate | 980, 3500 |
| Zn4SO4(OH)6.4H2O | Namuwite | 960, 3610 |
| Zn5(OH)8Cl2.H2O | Simonkolleite | 250, 395, 3490 |
| Mix CO3-SO4-OH | - | 980, 1060, 3500 |

**References for Raman peaks assignment:**

1. Colomban, Ph.; Cherifi, S.; Despert, G.; Raman identification of corrosion products on automotive galvanized steel sheets, Journal of Raman spectroscopy, 39 (7), 2008, 881-886.
2. Falgayrac, Guillaume; Sobanska, Sophie; Bremard, Claude;Raman diagnostic of the reactivity between ZnSO4 and CaCO3 particles in humid air relevant to heterogeneous zinc chemistry in atmosphere, Atmospheric Environment, 85, 2014, 83-91.
3. Azevedo, M. Salgueiro; Allely, C.; Ogle, K.; et al.; Corrosion mechanisms of Zn(Mg, Al) coated steel in accelerated tests and natural exposure: 1. The role of electrolyte composition in the nature of corrosion products and relative corrosion rate, Corrosion Science, 90, 2015, 472-481.

**Table S2.** Ba and Bc values for pristine and aged wires in 0.1 M NaCl and 0.1 M Na2SO4.

|  |  |  |  |
| --- | --- | --- | --- |
| **Test solution** | **Wires** | **Ba (V/dec)** | **Bc (V/dec)** |
| 0.1 M NaCl | HDG | 0.027±0.003 | 1.109±0.31 |
| Aged Belgium | 0.018±0.001 | 0.249±0.03 |
| Aged Indonesia | 0.036±0.005 | 0.287±0.12 |
| 0.1 M Na2SO4 | HDG | 0.010±0.001 | 1.091±0.49 |
| Aged Belgium | 0.012±0.001 | 0.238±0.02 |
| Aged Indonesia | 0.025±0.004 | 0.181±0.01 |