

Dataset for 'Zinc Hybrid Sintering For Printed Transient Sensors And Wireless Electronics'

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This data set contains the data collected during the FNS project Green Piezo (Grant no. 179064) in association with the publication titled 'Zinc Hybrid Sintering For Printed Transient Sensors And Wireless Electronics'.

The data set consists of the following folders:

- 1: Hybrid sintering characterization
- 2: Reliability measurements
- 3: Demonstrators
- 4: Physical characterization
- 5: Designs

Below is a detailed description of the file naming conventions and folder contents.

File naming conventions

The data in this dataset stems from various recording modalities, experiments, designs and devices, and the detailed file naming conventions for each experiment type are described below. In general, the files are named according to the following convention: [Date]_[Experiment]_[Experiment modality]_[Additional info]. Underscores separate hierarchical information about the data file while dashes are used to separate words within said information category. The date is formatted as follow: YYYYMMDD.

File types

The following data types are present in the dataset. All data types can be accessed and analyzed with open-source software. `.csv`: The data is comma delimited and can be opened with any text editor. `.csv` data files in this dataset contain headers where relevant information to the file are given (e.g. design file, substrate used, UNIX timestamp marking the beginning of data acquisition). The data is organised in columns where the first line represents the label for the columns. The rows in the data represent different samples or different timepoints, as indicated in the header. `.txt`: As for the `csv` files, they can be opened with any text editor. The data is delimited by spaces and the quantities and units of measurements are indicated in the columns. `.edf`: This data is recorded by the Sensirion SHT4x humidity and temperature sensors and is organised in a similar fashion to the `.csv` data described above. It can also be opened with any text editor. `.tif`: High-resolution image data acquired with a scanning electron microscope, which can be opened with any image viewer/editor. `.dxf`: Drawing Exchange Format files that contain the designs of the stencil and screens that were used to print the zinc electronics described in this publication. They can be opened with a vector files editor such as Inkscape.

01 Hybrid sintering characterization

This folder contains the experiments related to the combination of electrochemical and photonic sintering. The data is reported in terms of electrical resistance (Ohm).

01 Electrochemical treatment

Experiments studying the electrochemical sintering via spray deposition. The time dynamics of the process as well as the number of treatment cycles required are studied. The process is studied on several substrates (polyimide, polylactic acid (PLA), polyvinyl alcohol (PVA)). Files are named as follows: [Date]_Electrochemical_[Experiment]_[Substrate(s)].

[Experiment] can take the values *Cycles*, referring to experiments where the resistance is measured after several cycles of electrochemical sintering, *Dynamics*, a continuous measurement of the resistance of a printed zinc line under cycles of electrochemical treatment and *PVP-chainlength*, denoting experiments where the terminal resistance of zinc lines is measured after electrochemical sintering for different concentration of polyvinylpyrrolidone binder.

02 Photonic sintering

Experiments studying the addition of the photonic sintering step after the electrochemical sintering. The sub-folders refer to the material on which the experiments are conducted. Files are named as follows:

[Date]_Photonic_[Experiment]_[Experimental conditions]. [Experiment] can be *Atmosphere*, *Energy*, or *Pulsesnumber* denoting what specific parameter was varied in the experiment. More details can be found on the process in the publication.

On polyimide

Hybrid sintering experiments on polyimide.

On paper

Hybrid sintering experiments on Arjo-Wiggins Powercoat XD, 200 μm .

On PLA

Hybrid sintering experiments on polylactic acid.

On PVA

Hybrid sintering experiments on polyvinyl alcohol.

02 Reliability measurements

This folders contains the data for experiments related to the testing of the reliability of printed zinc which was sintered with the hybrid process described in the publication. The data is reported in terms of resistance (Ohm).

01 Degradation of conductivity

Experiments to study the degradation of the conductivity of printed zinc traces on polylactic acid over time in different environments (phosphate-buffered saline at 37 °C and in air at room temperature). Files are named as follows: [Date]_Degradation_[Environment and temperature]_[Encapsulation]_[Sintering protocol].

02 Cyclic bending

Experiments to study the stability of the conductivity of printed zinc traces on polylactic acid under cyclic bending at different radii (5 and 10 mm). Files are named as follows: [Date]_Bending_[Bending radius]_[Encapsulation]. The data is divided in subfolders that correspond to the bending radius and the presence or not of an encapsulating layer.

5 mm - encapsulated

Cyclic bending at a 5 mm radius with a polylactic acid encapsulation.

5 mm - no encapsulation

Cyclic bending at a 5 mm radius without encapsulation.

10 mm - encapsulated

Cyclic bending at a 10 mm radius with a polylactic acid encapsulation.

10 mm - no encapsulation

Cyclic bending at a 10 mm radius without encapsulation.

03 Demonstrators

This folder contains the data pertaining to the characterization of degradable sensors that rely on the hybrid sintering process for zinc that is presented in the publication. The data is divided in sub-folders that correspond to the sensing signal of interest (strain, temperature and pressure).

01 Strain

Measurements of the change of resistance of printed zinc on polylactic acid to bending, in both compression and tension.

02 Temperature

Measurements of the change of resistance of printed zinc (on and with polylactic acid encapsulation) to changes in temperature. The resistance is given in the *.csv* files and the measured temperature in °C in the *.edf* files. The files are named as follows: [Date]_Temperature_[Experiment]_[Data type], where [Experiment] refers to the change of temperature that was measured. [Experiment] can be *Staircase* (temperature is increased in steps of 1 °C) or *Fluctuation* (the temperature is arbitrarily varied between ~37 and 40 °C).

03 Pressure

Capacitive biodegradable sensors for the measurement of forces, where the sensors are made of printed zinc, polylactic acid and poly(octamethylene maleate (anhydride) citrate). The files are named as follows: [Date]_PressureSensing-(Wireless)_[Experiment]_[Force range]. The data for capacitive wired sensors and for RLC wireless sensors (labeled wireless in the file name) is present in the folder. For each recording two file types are provided: a force recording (*.csv*), and respectively a capacitance recording (*.txt*) for the wired sensors, or the reflection coefficient S11 recording for the wireless sensors. Additionally, the python script that was used to interpolate the S11 data and extract the resonant frequency is provided as *extract_resonance.py*.

04 Physical characterization

This folder contains measurement data that relates to the physical characteristics of the sintered printed zinc when using the two-step process described in the publication.

01 Profiles as a function of sintering protocol

Profilometry data obtained with a laser scanning confocal microscope (Keyence VK-X1000), where the profiles of printed zinc are measured after printing and each sintering step. The files are named as follows: [Date]_Profile_[Sintering state]. [Sintering state] can be *NoSintering* (after printing and solvent evaporation), *Electrochemical* (after acetic acid sintering), and *Hybrid* (after the two-step sintering process).

02 SEM characterization

SEM images of the microstructure of the printed zinc after printing and after each sintering step. The files are named as follows: SEM_[Sintering state]_[Printing method]_[Magnification], with [Printing method] being *Screen* or *Stencil*.

05 Designs

This folder contains the designs that were used for the printing of zinc test devices and demonstrators, as referenced in the header of the data recording files when relevant.