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IRES Innovation in Research & Engineering Solutions

Nano-integrity in 3D printing

Vanessa Lislevand (vlislevand@innovation-res.eu), Dimitris Karasavvas (dkarasavvas@innovation-res.eu)

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IRES Use Case on nano- materials

Scope

A series of **field measurements** to characterize **airborne particle** number **concentration** (PNC) from **Additive Manufacturing** (AM) activities

Goal:

- Develop an **ontology describing the domain expertise involved**
- Create a **triple store database** based on the developed ontology with the data collected during the use case.

IRES use case procedure in a nutshell

PETG

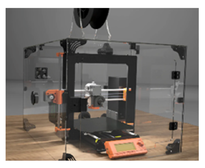
ABS

nanoCopper

- **Select** 3D printing filaments (PETG, PLA, ABS)
- **Print** simple objects
- Perform **nanoparticle emission measurements** during the 3D printing process
- **Nanoindentation** testing on **filaments** and **printed objects** -> Measure **(nano)mechanical properties** (nanoHardness and nano Elastic Modulus)
- **Integrate** collected **data** via **domain ontologies** and **top-level ontologies** like EMMO in a **triple store database** with reasoning capabilities
- **Analyze** the potential causal **relationships** between the **nanomaterial characterization process** and **safety risks** via inference and querying.

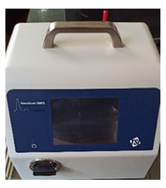
3D printed objects

3D Printer

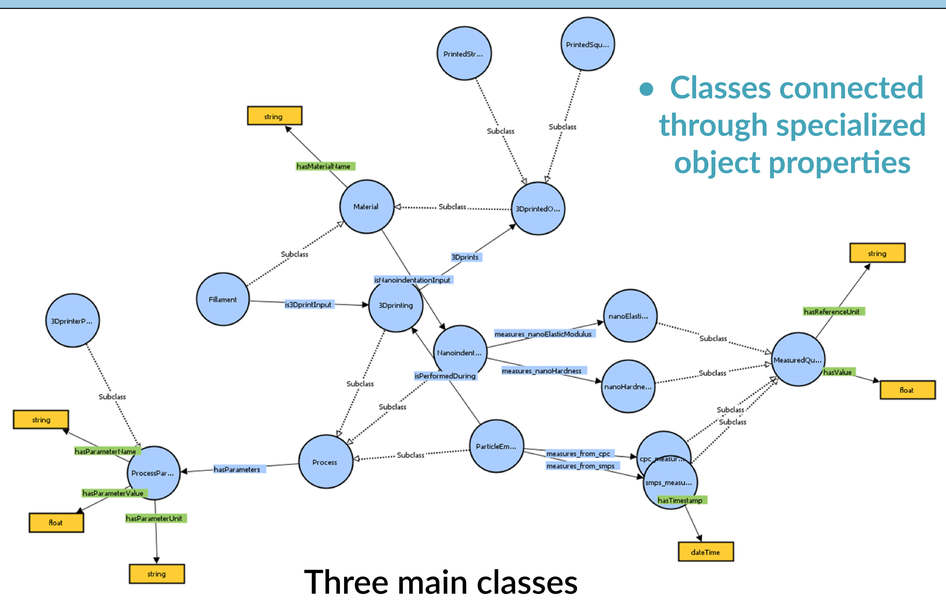


NanoIndenter

Nanoparticle emission measurement during 3Dprinting



IRES use case - Ontology



- Classes connected through specialized object properties

Three main classes

1. Material
2. Process
3. Measured Quantity

Integration into Mechanical Testing Ontology - Oyster [1] (EMMO based)

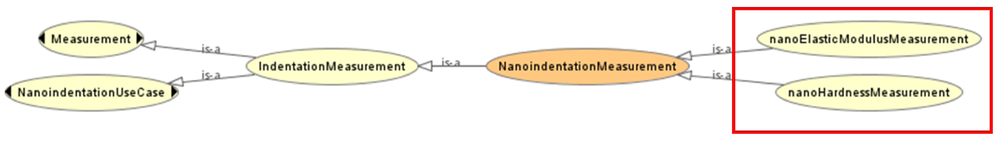
1. Extend the EMMO Ontology by introducing new classes related to IRES use case

Extend the class NanoindentationSpecimen with:

- Filament (feedstock for printer)
- 3DprintedObject
- PrintedSquare
- PrintedStripe

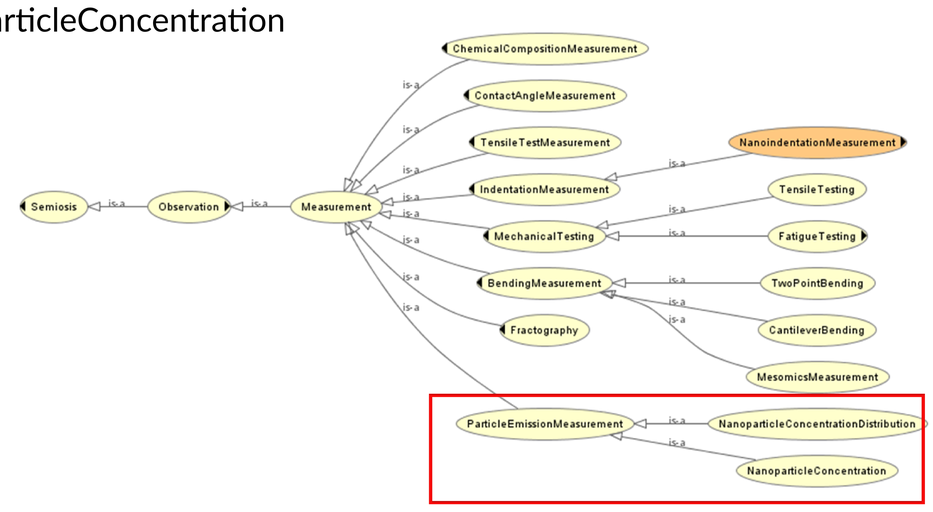
Extend the class NanoindentationMeasurement with:

- nanoHardnessMeasurement
- nanoElasticModulusMeasurement



Extend the class Measurement with:

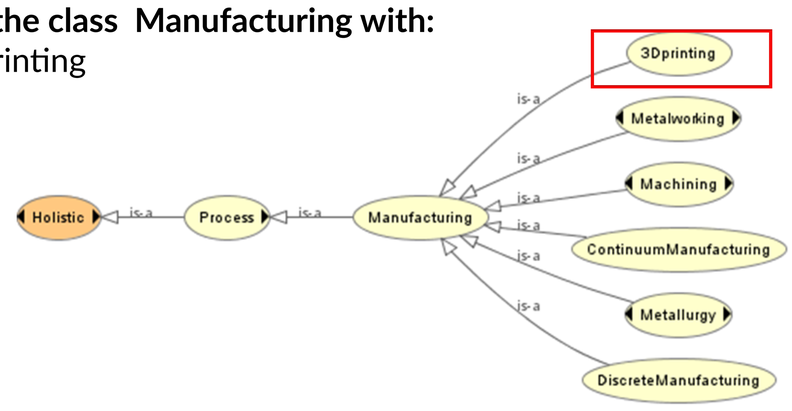
- ParticleEmissionMeasurement
- NanoparticleConcentrationDistribution
- NanoparticleConcentration



*These classes could be part of the eNanoMapper ontology[2] (BFO based) once the BFO and EMMO top level ontologies are aligned.

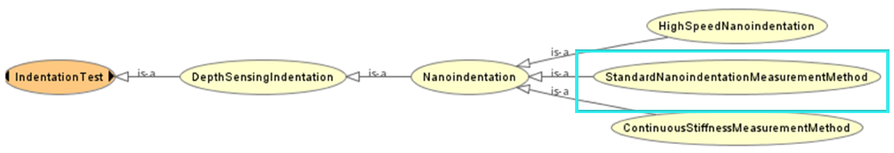
Extend the class Manufacturing with:

- 3Dprinting



*This class could be part of the AM ontology[3] (BFO based) once the BFO and EMMO top level ontologies are aligned.

2. Replace classes from the standalone ontology with the existing EMMO classes of the Mechanical Testing Ontology



Replace our Nanoindentation class with:

- StandardNanoindentationMeasurementMethod

Summary

- A **"standalone" ontology** covering IRES's use case has been developed.
- Performed **alignment** between classes **of Mechanical Testing ontology** and our **standalone ontology**.

Future Steps

- **Object properties** need to be included in the ontology alignment.
- Integrate collected data in a **triple store database** based on developed ontology.
- **Align** our ontology with **3 domain ontologies** (Mechanical Testing Ontology - Oyster[1], eNanoMapper Ontology[2], AMontology[3])

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[1]https://github.com/emmo-repo/domain-mechanical-testing
[2]https://www.nanocommons.eu/nanosafety-ontology-extension-characterisation-ecotoxicology-and-mesocosm-terms-added/
[3]https://github.com/iassouroko/AMontology