INTEGRANO Case Study Information Sheet

Case Study Number and Title	**Case Study 4.2: Air Filters**
Case Study Owner	**AITEX**
Partners Involved in the Case Study and Their Role(s):	**AITEX (production of electrospun membranes)** **CNR-ISAC (management of the case study and functionality tests – filtration)** **UNITO (provider of Egyptian Blue micro and nano particles)** **CNR-ISSMC (provider of AgHEC or AgCur nanoparticles)**

- **Case study aim, scope and goals. Briefly indicate the synthesis and incorporation plans, the applications of the NMs and NEPs, and define the life cycle stages of the nanomaterial:**

  - **Case study objective:** (why are we addressing this case study? Which is its relevance? For whom/stakeholder?) e.g. development of a new photocatalytic element / component of device/material

    The case study is based on obtaining biobased and biodegradable cellulose acetate (CA) nanofiber membranes, to optimize filtration efficiency, with the addition of antimicrobial nanoparticles for infection control.

    Due to the size and characteristics of nanofiber webs, they exhibit excellent properties in multiple applications, including filtration and release of substances in cosmetics and biomedical applications.

    The case study is relevant due to the growing interest in the use of nanofibers, since, although they do not entail a high risk due to their typical format and size (100 – 500 nm), the membranes can be additivated with nanoparticles for their functionalization and/or controlled release.

    The case study is relevant for developers of products based on nanofibers, in the medical-health and cosmetic field. The case study is oriented towards filtration to be able to compare with results from previous related projects and take advantage of the experience of the CNR-ISAC in the characterization of products for filtration (general filtration and protective face masks in particular).

  - **Case study strategy:** innovation, substitution, improvement, accomplishment by studying further life cycle stages, data integration of an already investigated case study….

    The objective of the case study is addressed under different strategies:

- **Firstly, it is intended to replace materials previously used in nanofiber filtration (PA6 and PHB) with a biobased, biodegradable and easily accessible material (CA).**
- **Secondly, an improvement in functionality is addressed through the incorporation of antimicrobial nanoadditives to avoid infections.**
- **Finally, it is intended to study the subsequent stages of the product's life cycle to evaluate the toxicity and ecotoxicity of the product in its End-of-Life.**

- **Life cycle stage to be addressed:** (synthesis, and/or incorporation, and/or use phase and/or end-of-life)

  The case study involves changes in the different stages of obtaining samples.

  1. Synthesis: the change of material involves adjustments in the preparation of the precursor polymer solutions.

  2. Incorporation: a study of the incorporation of antimicrobial additives into nanofiber webs is required.

  3. End-of-life: the changes introduced require the study of the end-of-life due to the change of material and the incorporation of nanoparticles.

- **Are there pre-existing data available for this case study? E.g.**
  - yes previous life cycle stage(s) data like synthesis (if you are now addressing to the incorporation phase)
  - yes same life cycle stage, incomplete DoE matrix data

  Yes. Previous preparation and use life cycle stages data.

- **List of the (expected/addressed) relevant Key Performance Indicators (KPIs) for the case study), which imply experimental characterisation and tests:**
  - -p-chem properties: (such as Z-potential, nanoparticle size;…)

    Fiber diameter, thickness, grammage, amount of antimicrobial agent (if present).
  - functionality tests: (such as antibacterial or photocatalytic activity)

    Filtration tests and eventually antibacterial tests.

- Human Toxicity tests: which? (e.g. genotox, oxidative stress, ….) which end point? (e.g. skin, lung, intestine,…)

  No risk from inhalation has been reported, especially in the absence of loading with antimicrobial agents. Skin irritation test.

- Eco-tox tests: which? which addressed environmental compartment/ species? Which end point is addressed?

  Eco-tox tests in seawater and freshwater.

- Emission sampling campaign: which kind? (e.g. leaching, airborne NP sampling,…) Which environmental compartment? (air, water, soil?)

  Electrospinning takes place in a clean room and there are no risks for the worker (as the operator drives the instrument from outside).

- **List the relevant Key Decision factors (KDFs) (e.g. reagent concentrations, processing parameters, synthesis temperature) for the case study(*):**

  - **Minimum and sufficient number of KDFs:** e.g. 2 KDFs

    2 KDFs

  - **What KDFs:** (quantity addressed e.g. reagents in a formulation, processing parameters,…etc.)

    KDF1: Membrane grammage

    KDF2: Concentration of antimicrobial agent

  - **KDF is it a discrete or continuous variable?** (level / continuous e.g. number of nozzles in spray coating is discrete variable, flow rate is continuous variable)

    Continuous variables

  - **Unit of measurement of the KDF:** e.g. flow rate ml/min….

    KDF1: g/m^2 (for grammage)

    KDF2: %w (for the concentration (in weight) of the antimicrobial agent in the membrane)

  - **(for continuous) KDF values range:** eg. KDF1 0.5ml/min<flow rate<2.7ml/min, ….

To be evaluated. It depends on the preliminary test of "CA synthesis" and the requirements to have almost the same parameters for PA6 and CA (for a better comparison).

KDF1: 0,5 g/m^2 < membrane grammage < 7,5 g/m^2

KDF2: 0 %w < antimicrobial < 5 %w

- **(for discrete) KDF levels:** e.g. low, medium, high

(*) please note that:

- the KDF selection is primarily addressed to the targeted functionality level of the solutions (e.g. Nano material functionality, product functionality,….)
- KDFs may be selected based on process experience / use phase or end-of life options analysis ….
- KDF number is strongly affecting the number of experiments: e.g.
  - # **2** KDFs imply a minimum number of **6** measured samples with average value and uncertainty
  - #**3** KDFs imply a minimum number of **10** measured samples with average value and uncertainty
  - **….**
- KDF selection may be based on:
  - Process experts
  - Available previous (primary=specific and owned) data on process and its effects on experiment results
  - Available data from the literature, databases,….