**INTEGRANO Case Study Information Sheet**

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| **Case Study Number and Title** | **CAn. 3: BioBased Composite PU foam** |
| **Case Study Owner** | **CNR-IPCB and CNR-SCITEC** |
| **Partners Involved in the Case Study and Their Role(s):** | **ISAC and UNIMIB for Ecotoxicity investigation** |

* **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 n°3 refers to the production of bio-based nano-enabled rigid polyurethane foam at pilot scale. Nowadays, polyurethanes foams are obtained from synthetic petrochemical precursors because bio-based precursors negatively affect the functional and mechanical properties of the final product. These limitations can be overcome by the addition of selected micro and nano fillers (or a mixture). The optimum filler or combination of fillers is chosen depending on the property to be achieved. However, in order to avoid phase separation, fillers have to be added after partial or total functionalization. The research activities of the aforementioned materials are also at an advanced stage from a basic research point of view (@lab scale), while their scalability is still in an embryonic stage and there are currently no plants capable of processing them. It is therefore of great interest to study the realisation of a nanocomposite rigid foam on a pilot scale, both to produce a foam with properties similar to those of conventional foams, and to understand what the best production technology might be.
  + **Case study strategy:** innovation, substitution, improvement, accomplishment by studying further life cycle stages, data integration of an already investigated case study….
    - To this case study, the CNR-IPCB formulated bio-based nano-enabled polyurethane foam using selected nanofillers functionalised by SCITEC and implemented/set up a foaming plant with open mould to produce foam on a pilot scale. However, this pilot plant has a several limitations, which can be summarised as follows: i) manual filler addition, ii) VOC emissions from the open mould in which the foam is poured, iii) dust production during the cutting phase to make the panels.

The basic idea is therefore to study the environmental aspects of the current case study and then to find out how they can be improved by making changes to the production process, for example by using a suitable lid to limit the amount of VOC emission, limit the spread of dust into the air by using suitable mobile hoods.

* + **Life cycle stage to be addressed:** (synthesis, and/or incorporation, and/or use phase and/or end-of-life)
* Study the environmental aspects of the current case study and then to find out how they can be improved by making changes to the production process, for example by using a suitable lid to limit the amount of VOC emission, limit the spread of dust into the air by using suitable mobile hoods.
* **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)

X yes same life cycle stage, incomplete DoE matrix 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;…)
  + functionality tests: Thermal conductivity (by using suitable thermal flux) and mechanical properties in compressive mode according to the ASTM D1621 standard, by using a universal testing machine (model CMT4304 from Shenzhen SANS Testing Machine Co. Ltd, China) equipped with a 30 kN load cell and operating at a crosshead displacement speed of 5 mm min-1.
  + Human Toxicity tests: which? (e.g. genotox, oxidative stress, ….) which end point? (e.g. skin, lung, intestine,…)-This point will be evaluated with UNIMIB/ISAC
  + Eco-tox tests: which? which addressed environmental compartment/ species? Which end point is addressed? This point will be evaluated with UNIMIB/ISAC
  + Emission sampling campaign: which kind? (e.g. leaching, airborne NP sampling,…) Which environmental compartment? (air, water, soil?) To be evaluated with ISAC and UNIMIB
* **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:**
  + **What KDFs:** (quantity addressed e.g. reagents in a formulation, processing parameters,…etc.): Reagents and process design
  + **KDF is it a discrete or continuous variable?** 
    - Discrete variable:
      * two typologies of mixture fillers: Gas Beton-Silica functionalized/ Diatomite-Silica functionalized
      * lid or no lid on the mould during the foams production for VOC emission
  + **Unit of measurement of the KDF:** e.g. flow rate ml/min….
  + **(for continuous) KDF values range:** eg. KDF1 0.5ml/min<flow rate<2.7ml/min, ….
  + **(for discrete) KDF levels:** medium

(\*) 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,….