

# Taking Cues from Nanoparticle Emission Control and Aerosol Nanotechnology for Antiviral Devices

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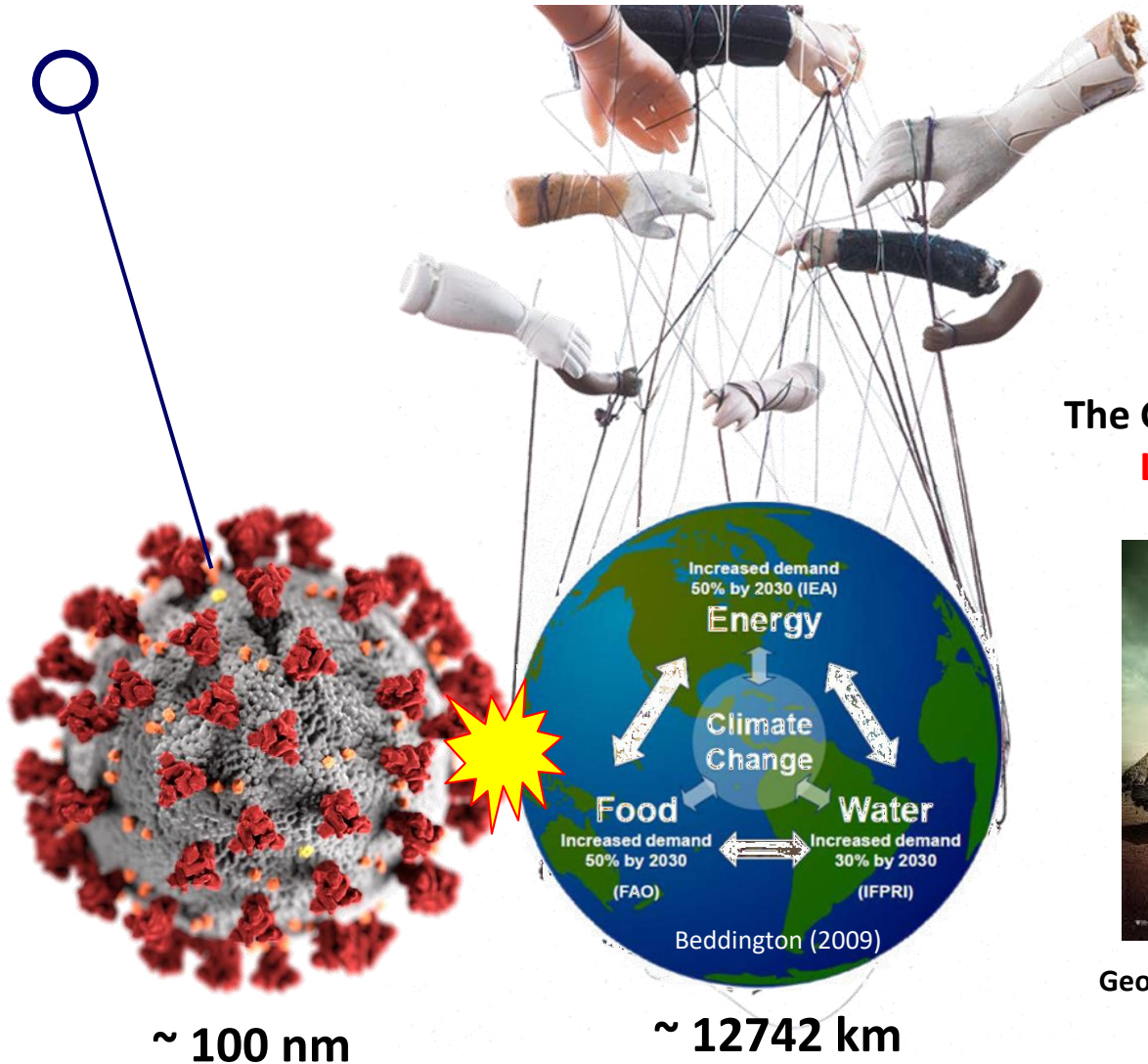
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1821-2021: 200 Years



# Grand Challenges: COVID Disrupts The Delicate Balances of the Global Resource Nexus

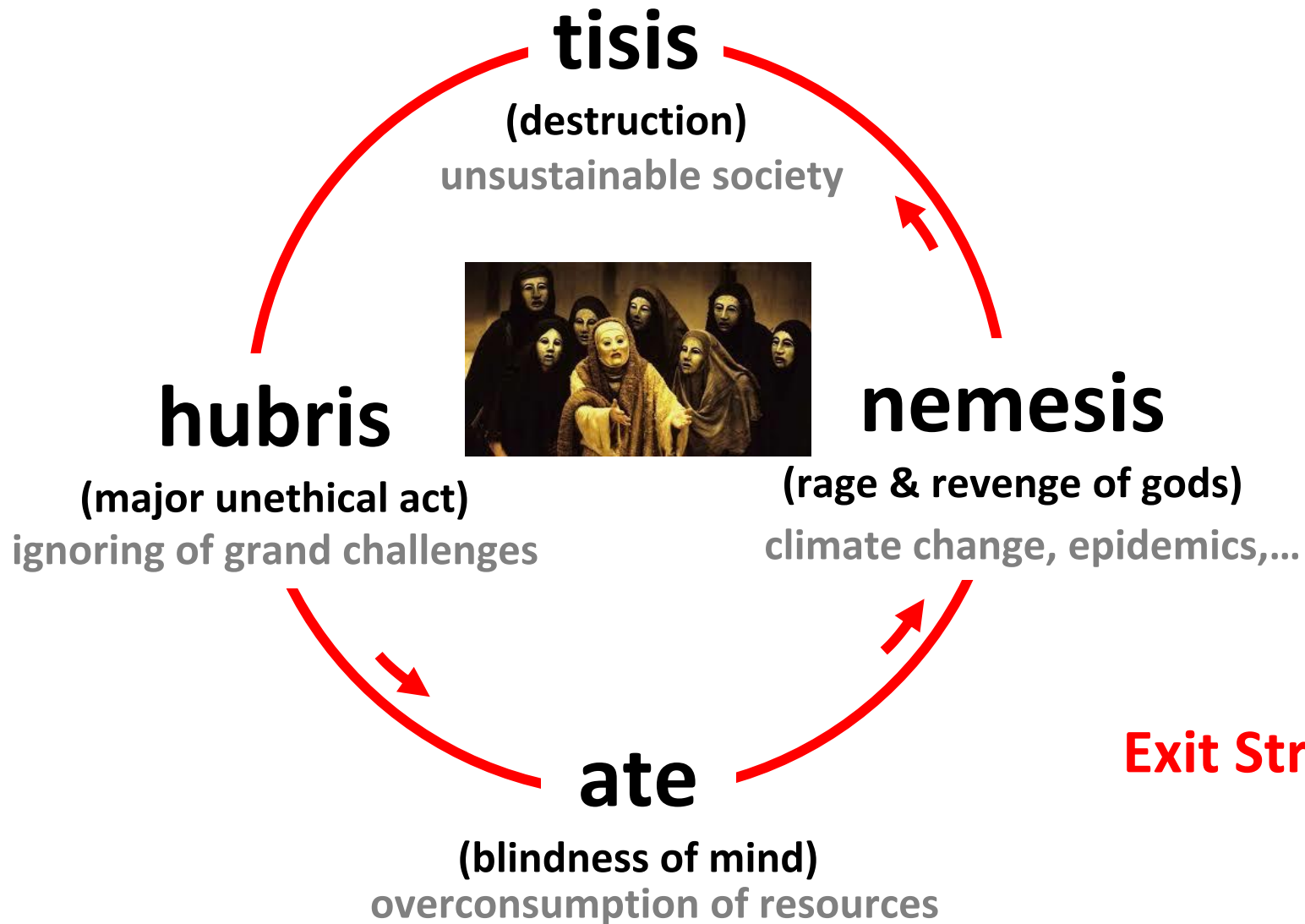


The Global Resource Nexus and the Struggle for  
**Land, Energy, Food, Water and Minerals**



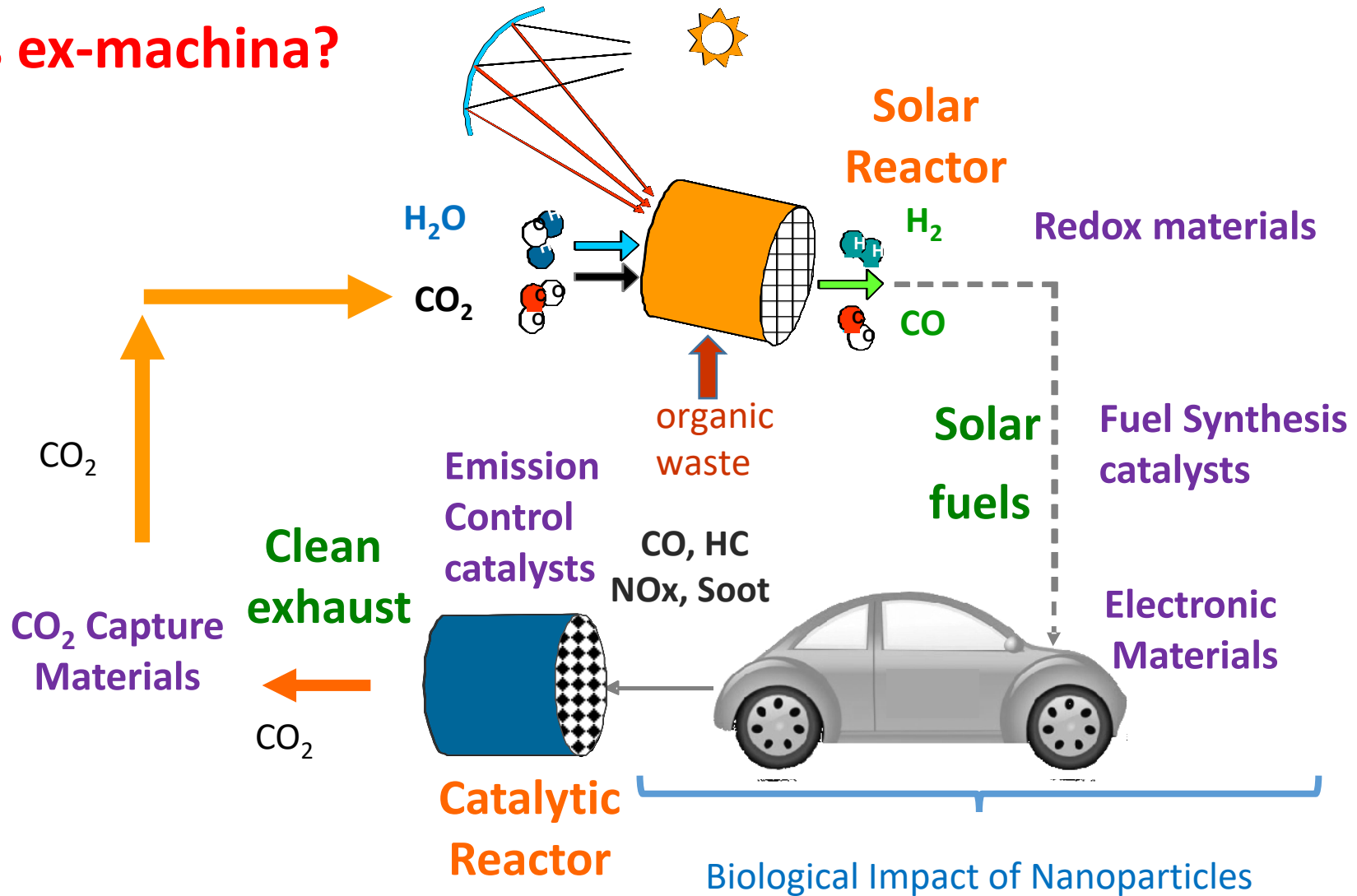
George Miller (2015) P. Andrews-Speed et al. (2015) Jared P. Scott (2016)

# The Tragic Cycle in Ancient Greek Drama



# Sustainable Energy and Mobility through Circularity

Deus ex-machina?



## Example of COVID challenge..

Many disposable filter element masks exist ...



© 3M



© Honeywell



© Copper3D



© CCIRC

...but their **utility** in times of the COVID pandemic has been **limited** due to **filter element availability** hence we look for inspiration to...

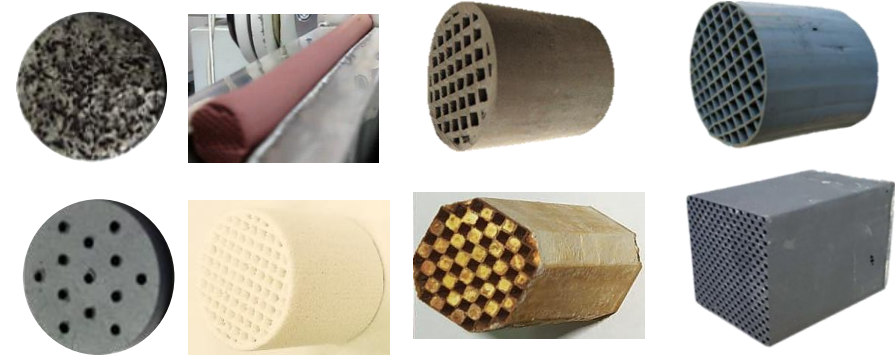
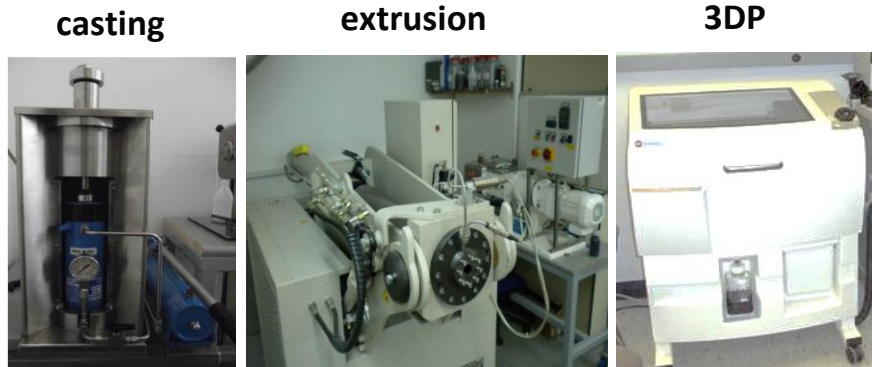
**30+ years of experience** in particle emission control, structured multifunctional reactors and aerosol nanotechnology

# Technology Cues ...

## ✓ Structures and Materials for filter media

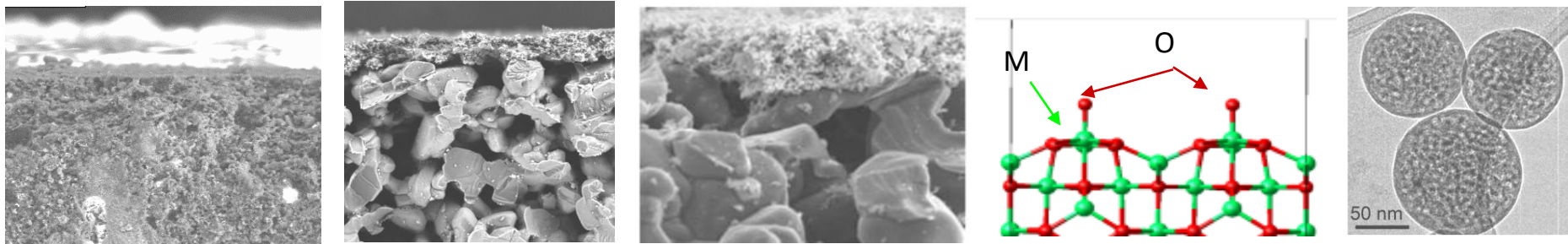
### Shaping/Forming Technologies

### Monolithic porous elements



Alternative formulations

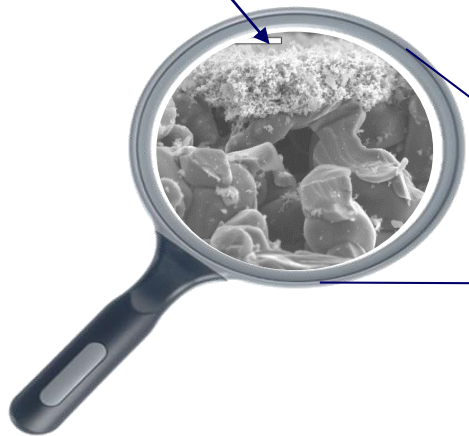
## ✓ Coatings for high filtration, catalytic activity and sorption/storage



# Features...

## Multifunctional Coatings

- ✓ Ultra high (99%) filtration efficiency
- ✓ Anti-viral function
- ✓ Moisture tolerant



## Reusable/Sterilizable

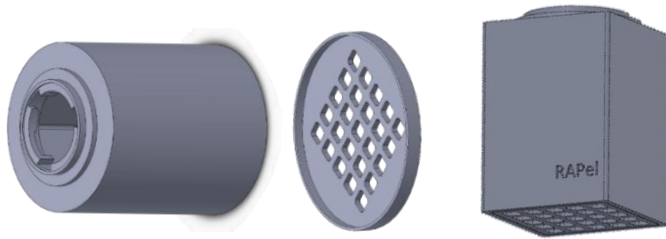
- ✓ Thermal/Oven
- ✓ Microwave

## Filter elements

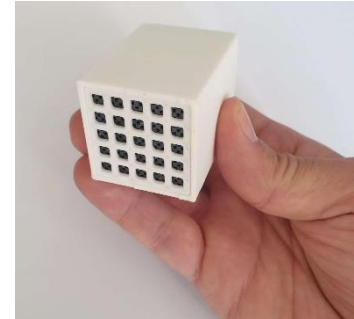
- ✓ High filtration area (3X of existing solutions)
- ✓ Low pressure drop for improved breathing
- ✓ Long use life between re-cleaning

# Development Path (under lockdown speeds...)

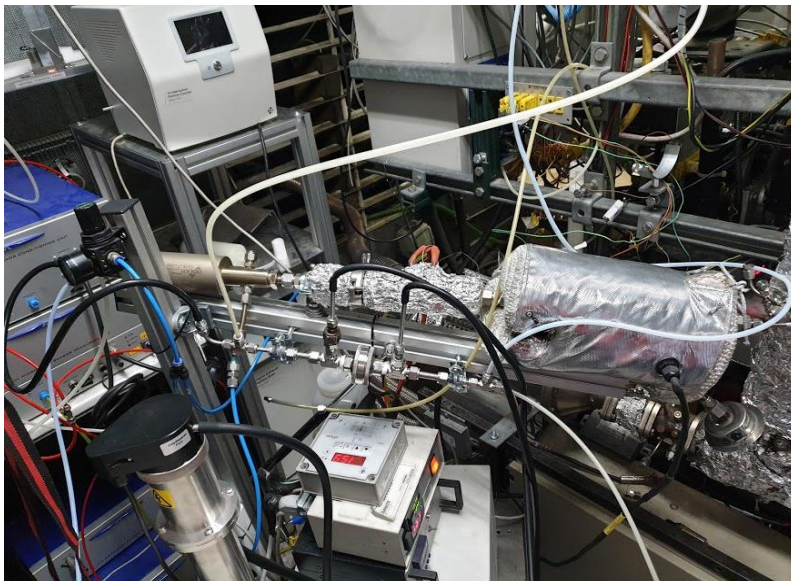
✓ Design



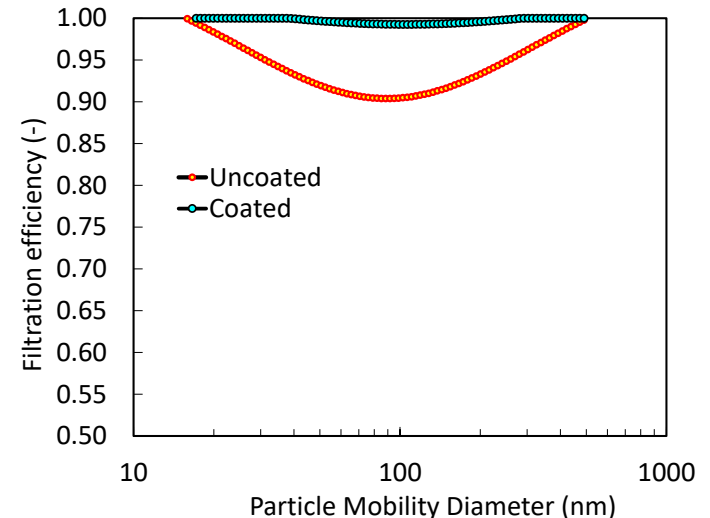
✓ Prototyping



✓ Testing with soot nanoparticles



**99% Filtration Efficiency**  
**@ >50% lower pressure drop than alternative**





# Minimum Viable Product Check List

- ✓ **Meaningful** – eliminates dependence on disposable filters and supply chain interruptions in times of crisis
- ✓ **Pleasurable** – exhibits low pressure drop/high breathability
- ✓ **Convenient** – easily sterilized/reused
- ✓ **Usable** – can be used in all disposable respirators/masks
- ✓ **Reliable** – made of inorganic/ceramic materials
- ✓ **Functional** – ultrafiltration/antiviral/moisture tolerant

# Value Proposition and Impact

- ✓ An **alternative to disposable filter** elements for health professionals and general public protection in times of crisis and a **sustainable replacement for the post-crisis future** avoiding plastic/organic waste
- ✓ It is based on a structured high surface area, functionalized (coated) monolithic body, **manufacturable by various options** to accommodate **local resources and capabilities**
- ✓ In mass production **cost** of a typical filter element is expected to be quite low

# What's next

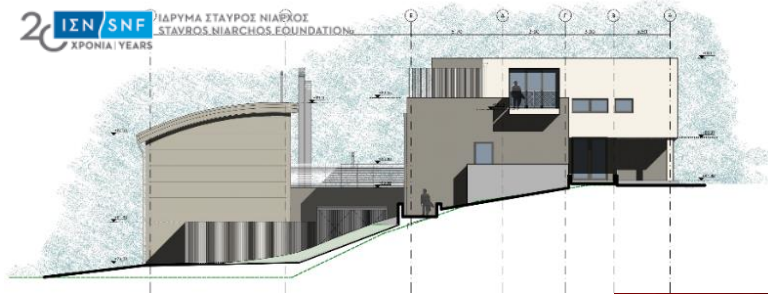
## Filtration and Coating Element Alternatives

- ✓ formulations for industrial scale
- ✓ formulations for in-shop/local manufacturing scale
- ✓ formulations for in-house/DIY

## Application Areas

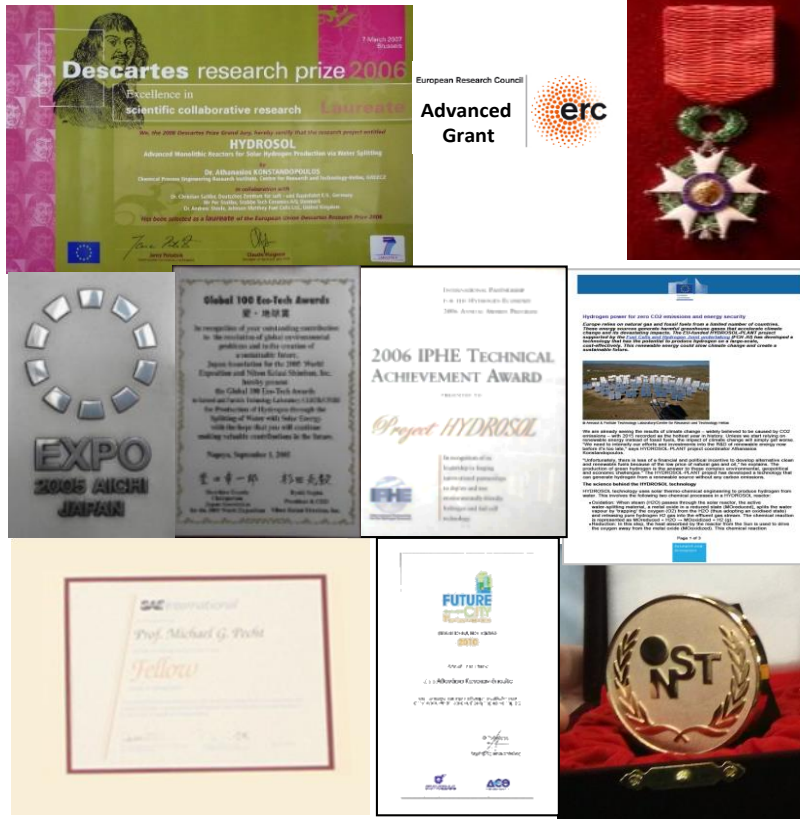
- ✓ Personal protection
- ✓ Mass transit media cabin air purification
- ✓ Indoor space air purification

# Thank you for your attention!



Breathe, breathe in the air,  
don't be afraid to care!

(Pink Floyd, 1973)



## Acknowledgements

- European Commission past and current projects (Hydrosol-Beyond, Zeocat-3D, Teesmat, Spider, ...)
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- Industrial partners including the Chorus cluster
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- Our colleagues at the APT Lab

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