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Exploring Innovative Adsorbents for Liquid Argon Purification from O_2 in Large LArTPCs

G. V. Oliveira, M. H. C. da Costa, A. M. Caffer, H. B. Pizzii, D. S. Passos, L. L. Pagliuso, C. R. A. dos Santos, F. Demolin, C. Adriano, A. A. B. Machado, E. Segreto, T. P. M. Alegre, F.C. Marques, P. G. Pagliuso – **IFGW/UNICAMP, Brazil**

I.O. Mazali – **IQ/UNICAMP, Brazil**

M. B. Fontes – **CBPF, Brazil**

R. Doubnik, Z. West, D. Montanari – **Fermilab, USA**

M. E. Ribeiro, R. G. L. Gonçalves, E. M. Assaf – **IQSC/USP, Brazil**

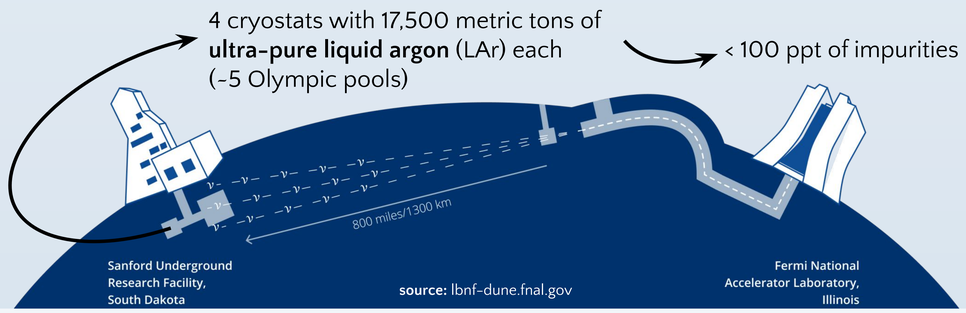
P. B. Neto, D. Noriler – **FEQ/UNICAMP, Brazil**

J. M. Assaf – **DEQ/UFSCar, Brazil**

C. G. M. Reis – **UFSJ, Brazil**

Deep Underground Neutrino Experiment

The **L**ong-**B**aseline **N**eutrino **F**acility (LBNF), located at the Sanford Underground Research Facility in Lead, South Dakota, hosts the **D**eep **U**nderground **N**eutrino **E**xperiment (DUNE).



Liquid Argon Time Projection Chambers (LArTPCs) require oxygen contamination levels below 100 ppt to ensure long electron lifetimes. In this work, we develop innovative copper oxide dispersive media based on Layered Double Hydroxides (LDH) and present a comparative performance analysis of them, specifically focusing on the impact of Cerium doping (Ce-LDH) versus pure CuMgAl-LDH (R-LDH) compared to the commercial copper-based adsorbent reference, BASF Cu-0226 S.

Proposal

- **Liquified Argon (LAr)** as target for neutrino experiments
- **Oxygen** contamination needs to be **< 100 ppt**.
- Production of **LDH media** and comparison to the BASF Cu-0226 S reference media.

Experimental Details

Materials:

- Copper-based materials prepared by coprecipitation.
- Production of pellets of the R-LDH in cylindrical form (1 mm length).

Fig. 01: Extruded R-LDH.

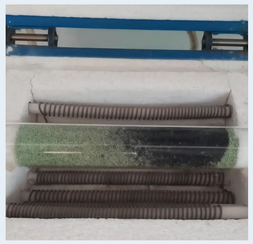


Fig. 02: R-LDH undergoing activation.

R-LDH Activation:

1. Heating up to 500°C (ramp 10°C/min) in the furnace (color change to green).
2. Reduced under 2.5% H_2/Ar (v/v) mixture flowing at 4 L/min at 300°C for 1h (color change to black).

Liquid **Ar**gon **Pu**rification **Cr**yostat - **PuLArC**:

- 0.3 kg R-LDH and 1.5 kg of commercial BASF in the filters.
- 90 L of commercial LAr (Purity: 99,999 %).
- Controlled contamination with roughly 20 ppm of O_2.
- 4 L/min LAr flow through the filters.

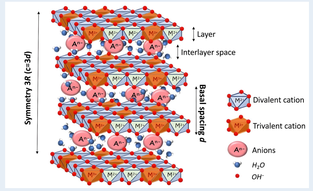


Fig. 03: General **L**ayered **D**ouble **H**ydroxide (**LDH**) Structure.

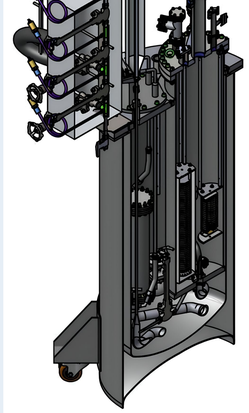


Fig. 04: Cryostat design of PuLArC.

Experimental Results

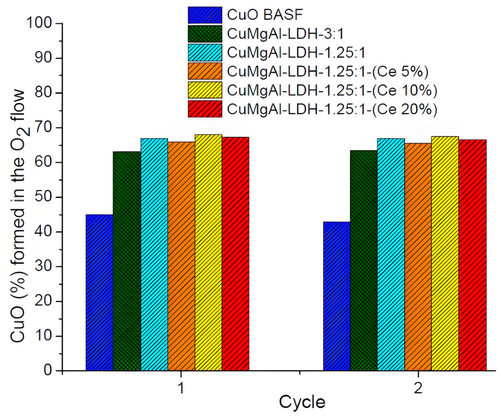


Fig. 05: Percentage of the area under TPR profiles after the oxidation cycle.

- Both R-LDH and Ce-LDH outperform the commercial counterpart.
- 10% Ce-LDH doping achieves the best performance.

In Situ Validation

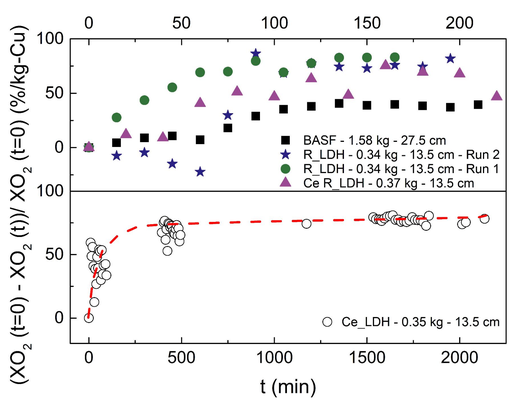


Fig. 06: Relative O_2 capturing with respect to the initial O_2 concentration normalized by the mass.

- Both LDHs outperform BASF Cu-0226 S in the PuLArC.
- Ce-LDH performance is comparable to the regular R-LDH sample.

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Next Steps

- Exclusive focus and further testing of the R-LDH sample.
- Updating PuLArC → Contaminant injection device.
- R-LDH Validation: From PuLArC to **ProtoDUNE**.

Acknowledgments

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References

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[2] G.V. Oliveira et al., *Analysing the performance of Ce-doped CuMgAl Layered Double Hydroxide for Oxygen adsorption*, Tech. Note 15, 2026.