

Preparation of UO_2 - PuO_2 MOX fuel by freeze granulation or slip casting

F. La Lumia¹, L. Ramond¹, C. Pagnoux², G. Bernard-Granger¹

¹CEA Marcoule, 30207 Bagnols-sur-Cèze, France

²IRCER, 87068 Limoges, France

Objectives

The current production of MOX fuels is carried out by a dry process, involving steps with fine powders (grinding, mixing, pressing). In order to limit dust dissemination in glove boxes and have a better U-Pu homogeneity in the final material, new wet processes are investigated.

Materials & methods

The key step of these wet processes is the preparation of a stable and well-dispersed aqueous UO_2 - PuO_2 suspension through the use of an appropriate wet-mixing process and an optimized amount of proper dispersant, in order to have a charged, yet fluid, homogenous and settling-resistant suspension. Two different liquid processes are then intended from these suspensions:

- freeze granulation (Fig. 1): the suspension is atomized into liquid nitrogen. Suspension droplets freeze instantly into frozen granules, which are eventually freeze-dried to yield a granulated powder. Granules are shaped into green pellets by uniaxial pressing [1].
- slip casting (Fig. 2): suspension is poured into a porous mold. Its porosity extracts the water from the suspension by capillarity, eventually leaving a green pellet.

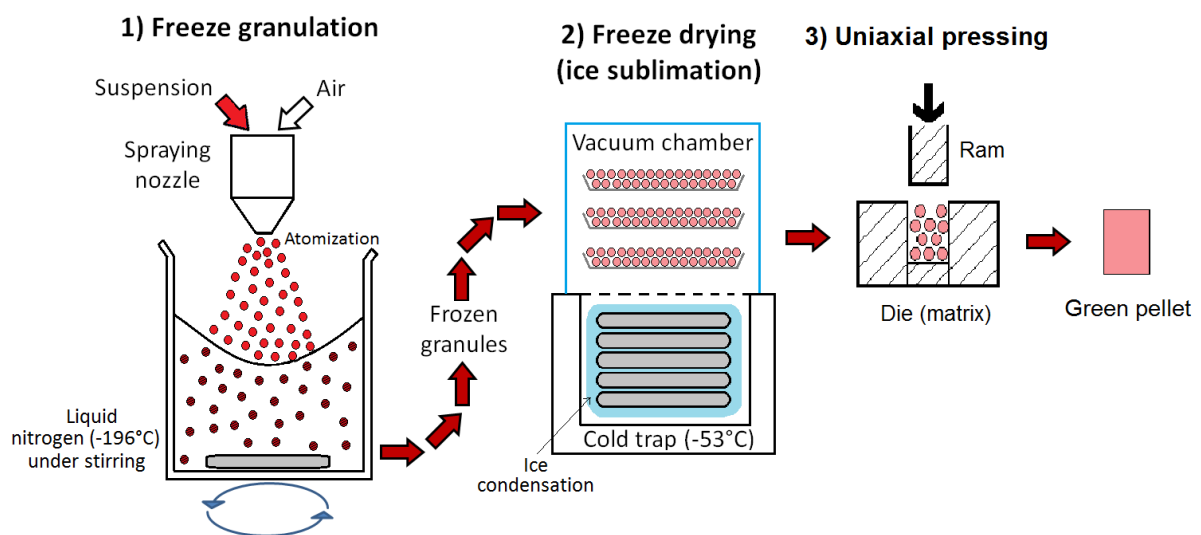


Fig. 1: Principle of the freeze granulation process.

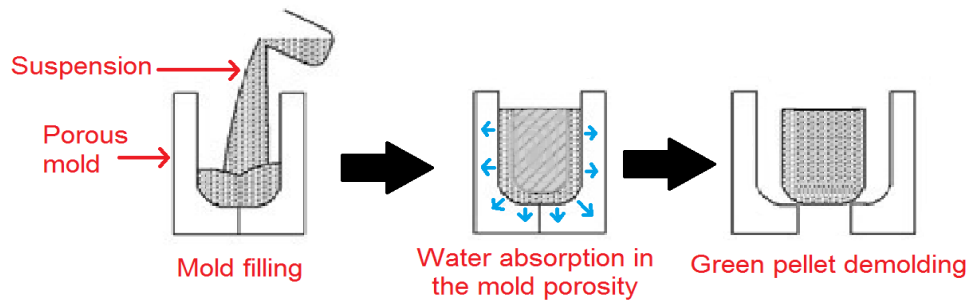


Fig. 2: Principle of the slip casting process.

Results

The use of grinding balls and roller mixer has proven to be an efficient process to prepare charged (30-35 %v solid loading, i.e. 80-85 %m) $\text{UO}_2\text{-PuO}_2$ aqueous suspensions, in combination with polymethacrylate dispersant. These suspensions exhibit good dispersion (assessed by acoustophometry through the measurement of zeta potential) and settling resistance, despite the materials high density (around 11 g/cm^3 for UO_2 and PuO_2). Rheology measures have proven the suspension viscosity to be low enough to allow atomization. From these optimized suspensions, MOX green pellets were formed by the two aforementioned processes. Their sintering behavior and microstructure were then characterized in detail.

Conclusions

Two liquid route processes, slip casting or freeze granulation, were applied to the preparation of MOX pellets from raw UO_2 and PuO_2 powders. Their main advantages upon the industrial dry process are: lower dust dissemination and better pellet homogeneity. The key step of these wet processes is the suspension preparation, which properties are bound to rheology and colloidal chemistry considerations.

References

- [1] K. Rundgren, O. Lyckfeldt, M. Sjöstedt. Freeze granulation for the processing of silicon nitride ceramics. *Key Eng. Mater.* 264-268 (2004) 281-284.