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EUROPEAN ATOMIC ENERGY COMMUNITY - EURATOM

ON A CASE OF SOLARIZATION DURING STEAM SINTERING OF UO_2 PELLETS

by

I. AMATO R.L. COLOMBO A.M. PROTTI
(FIAT, Sezione Energia Nucleare)

1963

Euratom — United States Agreement for Cooperation
Work performed by FIAT S.p.A.
under the Euratom Contract No. 016-60-9 RDI
(Part of the EURAEC Report No. 321)

Reprinted from
JOURNAL OF NUCLEAR MATERIALS
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JOURNAL OF NUCLEAR MATERIALS 8, No. 2 (1963) 271–272, NORTH-HOLLAND PUBLISHING CO., AMSTERDAM

ON A CASE OF SOLARIZATION DURING STEAM SINTERING OF UO_2 PELLETS†

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Manuscript received October 1962

Solarization is the decrease of density in sintered bodies, which takes place with the increase of the treatment time or temperature.

Occurrence of solarization in uranium dioxide is reported occasionally in the literature during hydrogen sintering of certain powders [1,2]). We have observed it during sintering in steam atmosphere on material, which did not show evidence of it during hydrogen sintering.

The powder was purchased from the CNEN (National Committee for Nuclear Energy) and was produced through the "wet process" (oven-drying of hydrated oxyde precipitated from tetravalent Uranium solution) [3]). The O/U ratio was 2.02 and the surface area 3.6 m^2/g. Pellets were pressed to about 7 g/cm^3 with the addition of 1 % in weight of PVA and 1 % of stearic acid.

Some were sintered in a hydrogen atmosphere and had a final density only slightly inferior to that of pellets made with other kinds of powder.

The steam sintering cycle was the following:

1) Heating up in nitrogen to 800° C.
2) Heating up in hydrogen to 1398° C.
3) Soaking in steam at 1398° C for various periods of time.
4) Cooling down in hydrogen from 1398° C to 800° C.
5) Cooling down in nitrogen to RT.

Heating and cooling rates were kept as low as 5° C/min.

Fig. 1 gives the plot of the fired density versus the soaking time: one may see that beyond 2 h the fired density starts to decrease even though it is still below that expected for such powder.

Micrographic examination of the sintered bodies gives some explanations of this phenomenon. Steam sintering of the CNEN powder is characterized by discontinuous grain growth from its early stages (fig. 2). This, according to Coble and Burke's theory [4,5]), would result in poor densification, since very soon the majority of the closed pores would become isolated from grain boundaries and cease to shrink.

At this point one would expect little further sintering; the decrease in the fired density is possibly due to the pressure of the gases trapped in the isolated pores, which causes some of them

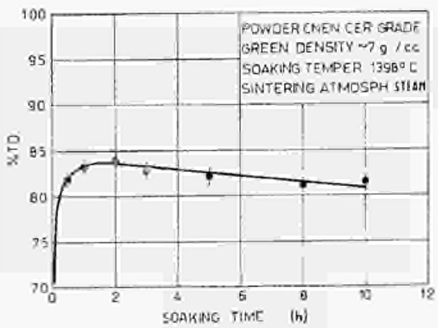

Fig. 1. Fired density versus soaking time during steam sintering at 1398° C.

Powder: CNEN Cer grade — Soaking temp.: 1398° C.
Green density: ≈ 7 g/cc — Sintering atm.: steam

† Work performed under Euratom/USA contract n° 011–60–9–RDI.

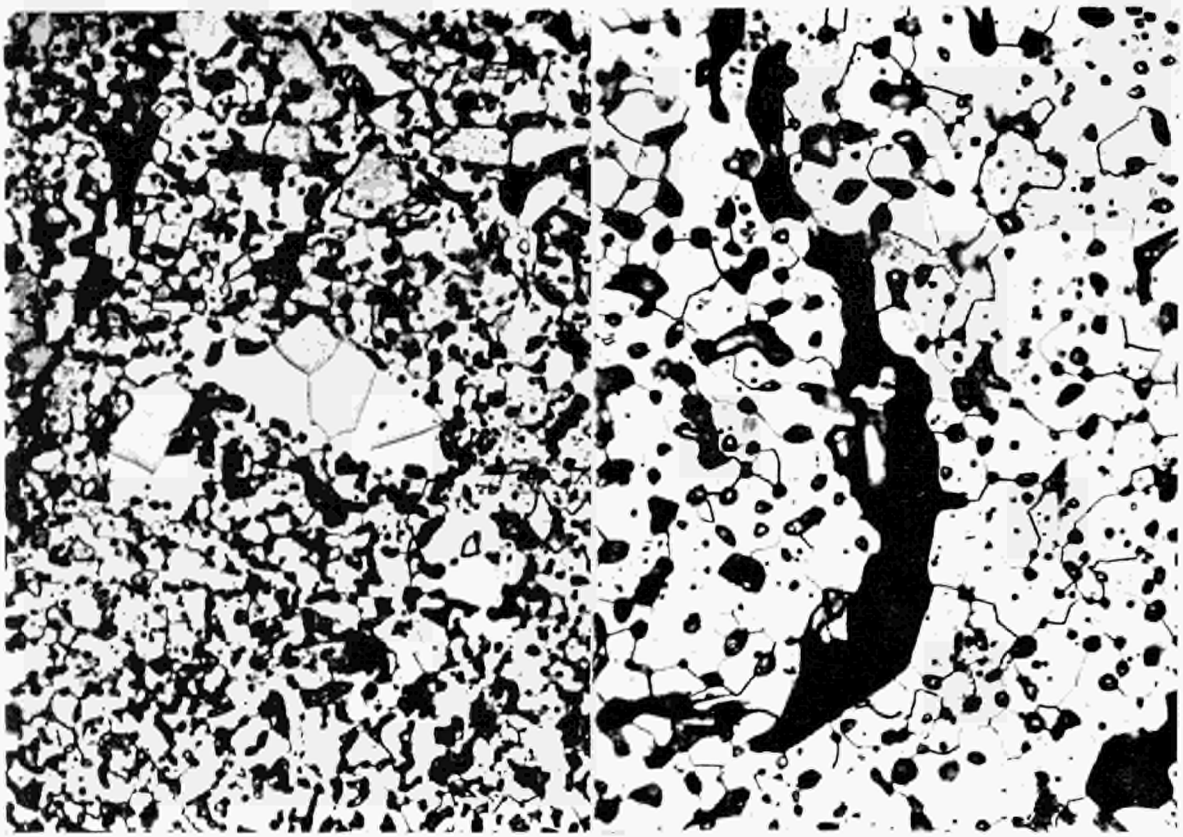

Fig. 2. Discontinuous grain growth at the beginning of steam sintering at 1398° C. Soaking time: 30 min. T.D.: 81.8 % etched. × 1000

Fig. 3. Cavity formation during solarization. Soaking time: 5 h, T.D. 82.0 % etched. × 1000

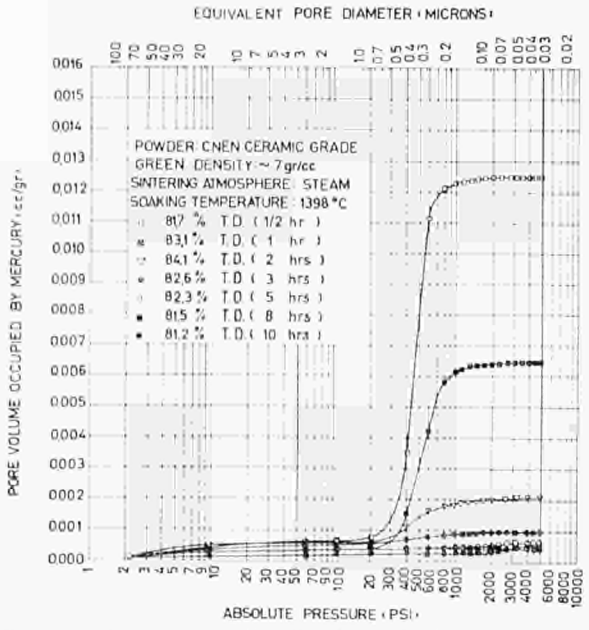

Fig. 4. Open pore distribution (Aminco–Winslow) for isothermally sintered pellets.

to merge owing to plasticity effects: fig. 3 shows one of the big cavities formed in a solarized specimen.

That solarization is not due to some reverting of sintering is shown in fig. 4, which indicates that the open porosity is less for a solarized specimen than for a non-solarized one having higher density.

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