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Synthesis of Nanoporous Materials by Magnesium-Thermal Reduction of Oxide Compounds of Tantalum and Niobium

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One of the ways to obtain powders with a large specific surface area is the reduction of tantalum and niobium pentoxides with magnesium vapor [1]. Due to the peculiarities of the reduction mechanism of these compounds with magnesium vapor, metal powders are obtained, the particles of which are characterized by a mesoporous structure [2].

Complex oxide compounds of tantalum and niobium, for example, $Mg_4Ta_2O_9$, $Mg_4Nb_2O_9$, can also be used as reduction precursors. The resulting metal powders also have a mesoporous structure, but with a smaller thickness of metal particles and magnesium oxide particles separating them. Essentially, the reduction product is a nanoscale composite: metal-magnesium oxide. After leaching of magnesium oxide, the metal particle is a spongy structure, the specific surface of which is determined by the number and size of pores [3, 4].

The parameters of the porous structure are determined not only by the reduction conditions, but also by the morphological features of the precursor itself.

For example, the reduction of tantalum pentoxide of various genesis under the same conditions yielded powders with a specific surface area of 4 to 20 m^2/g (**Fig. 1**) in which from 1/3 to 1/2 of the surface area falls on pores with a diameter of less than 5 nm (**Fig. 2**).

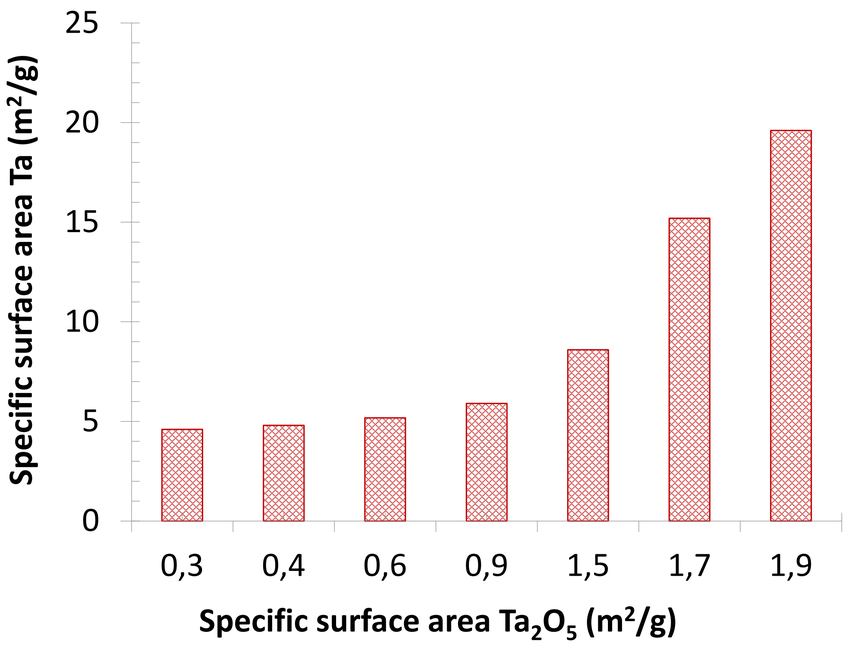


Fig. 1 – Specific Surface Area of Tantalum at Different Specific Surface Area of Ta_2O_5

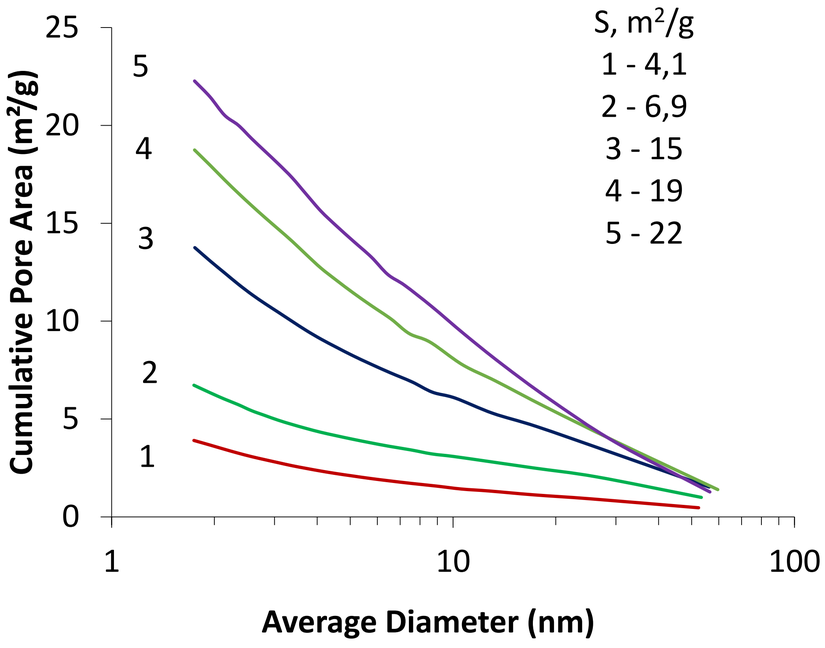
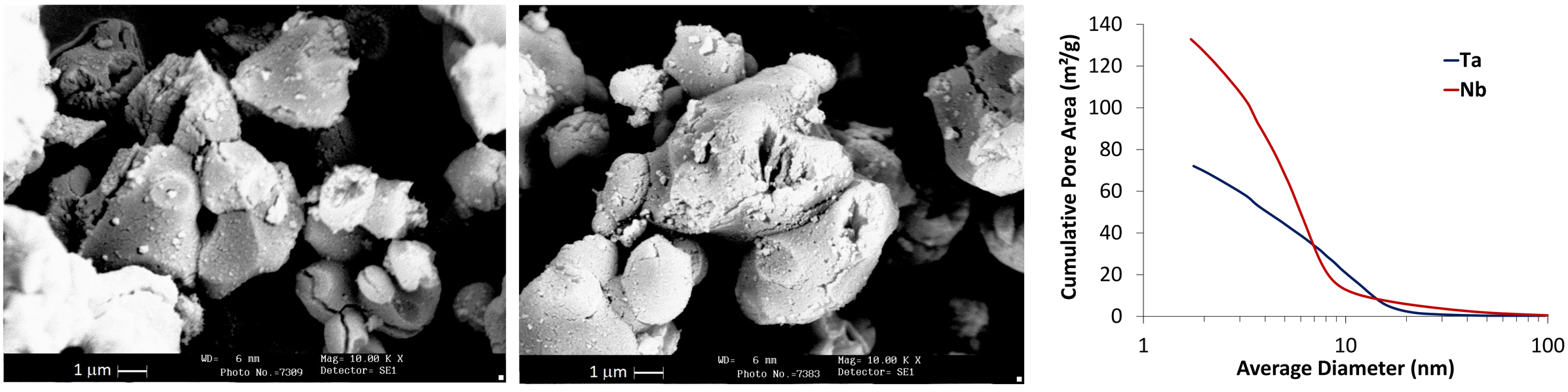


Fig. 2 – Cumulative Pore Area (Larger) of Ta Powders with Different Specific Surface Area

Considering this factor, using $Mg_4Ta_2O_9$ and $Mg_4Nb_2O_9$ as precursors, we obtained tantalum powders with a specific surface area of up to 80 m^2/g and niobium powders with a specific surface area of up to 170 m^2/g, in which from 1/2 to 2/3 of the surface area falls on pores with a diameter of less than 5 nm **(Fig. 3)**.



a b c

Fig. 3 – Microphotographs of (a) Tantalum (S=70 m^2/g) and (b) Niobium (S=130 m^2/g), and (c) BJH Desorption Cumulative Pore Area (Larger)

Referens:

[1] H. Haas, C. Schnitter, N. Sato [et al.] // CARTS Europe 2008 Proceedings. (2008) 157.
[2] R. Müller, M. Bobeth, H. Brumm, [et al.] // Int. J. of Materials Research. 98 (2007) 1138.
[3] V.N. Orlov, M.V. Kryzhanov, A.I. Knyazeva // Prot. Met. Phys. Chem. Surf. 52 (2016) 814.
[4] V.N. Orlov, M.V. Kryzhanov // Russian Metallurgy (Metally). 7 (2016) 596.