Ultrasonic analysis for nuclear fuel characterization

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Ceramic materials have been widely used for various purposes in many different industries due to certain characteristics, such as high melting point and high resistance to corrosion. Concerning the areas of applications, automobile, aeronautics, naval and even nuclear, the characteristics of these materials should be strictly controlled. In the nuclear area, ceramics are of great importance once they are the nuclear fuel pellets and must have, among other features, a well controlled porosity due to the mechanical strength and the thermal conductivity required by the application. Generally, techniques used to characterize nuclear fuel are destructive and require costly equipment, and also facilities. This paper aims to present a nondestructive technique for ceramic characterization using ultrasound. This technique differs from other ultrasonic techniques because it uses ultrasonic pulse in frequency domain instead of time domain, associating the characteristics of the analyzed material with its frequency spectrum. In the present work, 40 Alumina (Al_2O_3) ceramic pellets with porosities ranging from 5% to 37%, in absolute terms measured by Archimedes technique, were tested. It can be observed that the frequency spectrum of each pellet varies according to its respective porosity and microstructure (Figure 1), allowing a fast and non-destructive association of the same characteristics with the same spectra pellets [1-4].

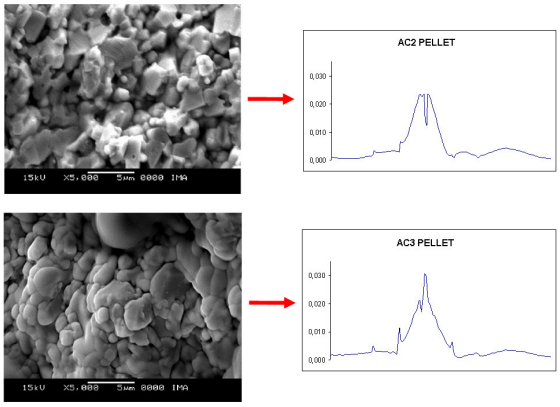

Figure 1 - Different pellets, both with 21.2% porosity, showed different spectra, which is justified by their different microstructures.

References

[1] Panakkal, J.P. J. K. Ghos, P. R. *Roy,* "Use of ultrasonic velocity for measurement of density of sintered fuel pellets". J. Phys. D: Applied Phys. 17, p. 1791-1795, 1984.

[2] Laux, D. et al., "Ultrasonic study of UO2: effects of porosity and grain size on ultrasonic attenuation and velocities". J. Nucl. Mat. 300, p.192-197, 2002.

[3] Young, M.C. et al., "Non destructive Evaluation of Nuclear Fuel Rods Using Ultrasonic Resonance Phenomena". 15th International Conference on Structural Mechanics in Reactor Technology , Seoul - Korea, 1999.

[4] Baroni, D. B. "Desenvolvimento de técnica ultrassônica para medida de porosidade em pastilhas de UO_2". Dissertação de Mestrado. Instituto de Engenharia Nuclear, Rio de Janeiro, 2008.