

## PALLADIUM NANOPARTICLES OBTAINED BY MECHANICAL MILLING

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In the last few years the interest in magnetic and biomedical applications of nanometre particles has increased due to the many phenomena observed which involve new important physical findings.

There are many different methods in order to obtain nanoparticles. Generally we refer to particles obtained by physical methods when physical procedures take place in the fabrication process as in mechanical milling or ionic implantation among others. Opposed to all these methods, there exist chemical methods like those based on the redox-controlled size- selective method

On the other hand, palladium is a particularly interesting 4d transition element since it can be characterized as a nearly ferromagnetic metal.

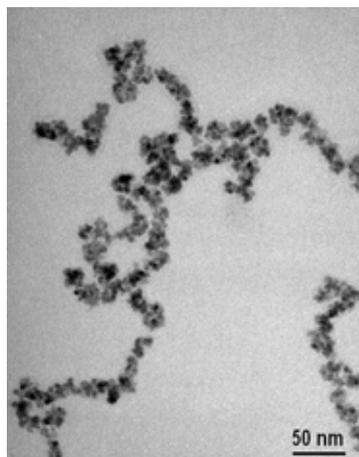
Pd powder samples were prepared by mechanical-energy high-transfer technique (ball milling) in agatha vessels for different milling times in the range comprehended between 6 and 120 hours.

In this work we present the HRTEM observation of Pd nanoparticles obtained by mechanical milling (fig. 1(a)). These particles are around 6 nm in size (fig. 1(b)). We have studied its magnetic properties as a function of the milling time. All the samples exhibit ferromagnetism (hysteresis, coercivity and remanence) up to room temperature (fig. 2). We suggest that the ferromagnetic order observed experimentally in these samples is related with the presence of the nanoparticles. This result is in good agreement with that observed by us [1] in fcc twinned 2.4 nm size Pd nanoparticles prepared by a chemical method.

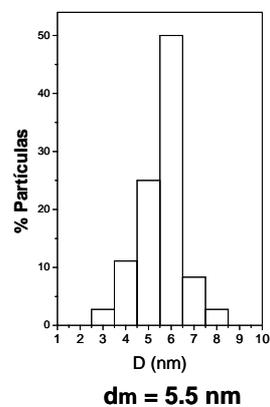
### References

1. B. Sampedro et al, *Phys. Rev. Lett.* **91**, 237203 (2003).

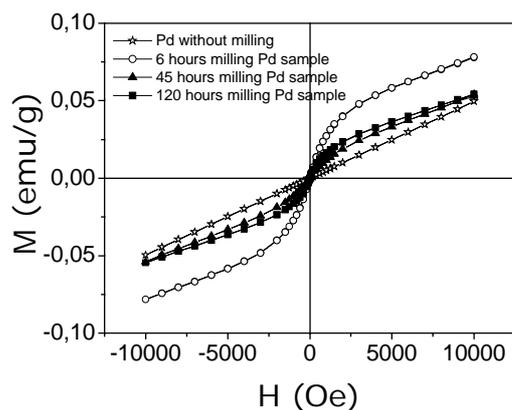
(a)



(b)



**Figure 1.** (a) HREM image of Pd nanoparticles obtained by mechanical milling. Particle size distribution histogram for the same Pd sample.



**Figure 2.** Hysteresis loops of Pd mechanically milled samples and a pure Pd sample one without milling at 300 K .