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Mechanical Alloying with the Cole-Parmer Mixer/Mill

SUBJECT (HT005): Mechanical Alloying
APPARATUS: Mixer/Mill®
APPLICATION: Production of Superalloys

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Cole-Parmer Mixer/Mills are routinely used for pulverizing rocks, minerals, sand, cement, slag, ceramics, catalyst supports, and hundreds of other brittle, often hard samples. Typically, samples are ground, then blended with binder before being pressed into sample discs for XRF analysis, or dissolved into solution for ICP analysis. The vigorous motion of the clamp is also excellent for making emulsions, such as paints, inks and pharmaceuticals. Mixer/Mills have also recognized for their ability to mechanically alloy small quantities of superconductor materials.

Mechanical alloying, also referred to as reactive milling, is a process originally developed for the production of oxide dispersion strengthened superalloys. Today, mechanical alloying is often used as a solid-state powder processing technique that generates powders with unique microstructures. A high-energy ball mill can be used to accomplish this. Over the past few decades, the BM-400 Mixer/Mill has become the industry standard for mechanical alloying applications. Benefits of this mill include the high energy of the milling action, continuous forced air cooling and the durability of the motor which allow running for extended periods.

The BM-400 Mixer/Mill is equipped with a timer that is factory set for a 100 minute time range. However, mechanical alloying requires significantly longer grinding times. For these applications, we offer an optional chip to extend the timer range to 10,500 minutes. This chip is available as either a factory-installed or user-installed option. Due to additional wear that can occur on the Mixer/Mill from extended running times, installation of this chip changes the warranty terms and a routine schedule of preventative maintenance is strongly suggested. For additional information please contact a Cole-Parmer application specialist.

Before and After Samples – Superalloy

Over the years, hundreds of articles have been published in peer reviewed scientific journals regarding the Mixer/Mill and its use for mechanical alloying. This includes mechanical alloying techniques, evaluations of grinding vial materials, and numerous other topics. The following publication list is intended to highlight some key publications and is not intended to be comprehensive. If you are considering the Mixer/Mill for your own mechanical alloying application, we encourage you to do your own search for application publications and references.

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Select Publications Pertaining to Mechanical Alloying

Effect of the heating rate on crystallization behavior of mechanically alloyed Mg50Ni50 amorphous alloy. Aydinbeyli, N., Nuri Celik, 0., Gasan, H., Aybar, K. International Journal of Hydrogen Energy, Vol. 31, Issue: 15, December, 2006. pp. 2266-2273.

Effect of ball milling on simultaneous spark plasma synthesis and densilication of TiCTiB2 composites. Locci, A.M., Orru, R., Cao, G., Munir, Z.A. Materials Science and Engineering A, Vol. 434, Issue: 1-2, October 25, 2006. pp. 23-29.

Temperature of the milling balls in shaker and planetary mills. Takacs, L., McHenry, J. S. Journal of Materials Science, Vol. 41, Issue: 16, August 2006. pp. 5246 - 5249.

Modeling of comminution processes in Spex Mixer/Mill. Concas, A., Lai, N., Pisu, M., Cao, G. Chemical Engineering Science, Vol. 61, Issue: 11, June, 2006. pp. 3746-3760.

Effect of mechanical alloying conditions on the microstructure evolution and electrode characteristics of Mg63Ni30Y7. Khorkounov, B., Gebert, A., Mickel, Ch., Schultz, L. Journal of Alloys and Compounds, Vol. 416, Issue: 1-2, June 8, 2006. pp. 110-119.

A study of mechanical alloying processes using reactive milling and discrete element modeling. Ward, T.S., Chen, W., Schoenitz, M., Dave, R.N., Dreizin, E.L. Acta Materialia, Vol. 53, Issue: 10, June, 2005. pp. 2909-2918. 53, Issue: 10, June, 2005. pp. 2909-2918.

Microstructural evolution during mechanical alloying of Mg and Ni. Rojas, P., Ordonez, S., Serafini, D., Zuniga, A., Lavernia, E. Journal of Alloys and Compounds, Vol. 391, Issue: 1-2, April 5, 2005. pp. 267-276.

Mechanical milling of magnesium powder. Hwang, S., Nishimura, C., McCormick, P.G. Materials Science and Engineering: A, Vol. 318, Issue: 1-2, November, 2001. pp. 22 - 33.

Formation of supersaturated solid solutions by mechanical alloying. Huang, B. -L., Perez, R.J., Lavernia, E.J., Luton, M.J. Nanostructured Materials, Vol. 7, Issue: 1-2, January 2, 1996. pp. 67-79.

Synthesis of nanocrystalline Fe-B-Si powders. Perez, R.J., Huang, B.-L., Crawford, P.J., Sharif, A.A., Lavernia, E.J. Nanostructured Materials, Vol. 7, Issue: 1-2, January 2, 1996. pp. 47- 56

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