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# 기계적 밀링에 의한 상분해 및 결정화

## Decomposition and crystallization induced by mechanical milling

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Decomposition of intermetallics (FeSn, CoSn, $Co_3Sn_2$ and $Al_3Ni$) and crystallization of an amorphous alloy ($Fe_{90}Zr_{10}$) induced by mechanical milling were investigated using X-ray diffraction, calorimetric and magnetization measurements. Upon milling a large amount of the FeSn intermetallic decomposes into $Fe_5Sn_3$ and $FeSn_2$, where the average grain size of the product phases stays nearly constant with milling-time. Similar observations are made for the CoSn intermetallic, which decomposes into $Co_3Sn_2$ and Sn. It is suggested that the mechanically driven decomposition of FeSn and CoSn results from local melting of powder particles due to high temperature pulses during ball collisions. In contrast to FeSn and CoSn, $Al_3Ni$ exhibits only a small decomposition degree and $CoIn_2$ does not decompose at all upon milling. The different decomposition behaviors of the studied intermetallics may be attributed to the volume changes occurring with a decomposition process. Whereas the decomposition of FeSn and CoSn into their product phases results in a strongly negative volume change, the decomposition of $Al_3Ni$ and $CoIn_2$ leads to an increase in volume. Hence, high local stresses under ball collisions are expected to make the mechanically induced decomposition of FeSn and CoSn favorable but rather hinder the decomposition of $CoIn_2$ and $Al_3Ni$.

Furthermore, the crystallization of amorphous $Fe_{90}Zr_{10}$, induced by high-energy ball-milling was investigated. For these studies, an amorphous $Fe_{90}Zr_{10}$ alloy was produced in the form of ribbons by arc-melting mixtures of pure Fe and Zr, followed by melt-spinning. The amorphous structure of the ribbons was confirmed by X-ray diffraction (XRD). High-energy millingunder protective Ar atmosphere led to a change from ribbon into very fine powder form and in particular to a change in the structure. After milling for 120 min a nanocrystalline structure was detected by XRD instead of the initial amorphous phase. According to the XRD data, such samples consisted of only bcc alpha-Fe crystallites, where a shift in the diffraction peaks indicated a supersaturation of the Fe-grains with Zr. Further detailed studies on the dependence of the crystallization process on the milling parameters such as milling speed and time and a comparison with the crystallization processes occurring upon thermal treatment will be performed.