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Twinning and the mechanical behavior of magnesium alloys at very high strain rates

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ABSTRACT

The dynamic mechanical behavior of magnesium and its alloys is a subject of interest primarily because of its high specific strength. This makes it attractive for structural components and vehicles. The hexagonal close packed crystal structure of magnesium makes it highly anisotropic in terms of its mechanical behavior. Extension twinning is a dominant deformation mechanism in these materials. This is often reflected in a characteristic sigmoidal profile of the stress–strain curve when crystals are compressed along directions perpendicular to the crystallographic *c*-axis. Past experiments have been limited to strain rates of 10^3 s^{-1} . This study focuses on microstructural twinning effects on the mechanical behavior of AZ31 magnesium alloy at higher strain rates. We perform very high-strain rate experiments on AZ31 magnesium alloy, using a miniature Kolsky compression bar apparatus coupled with a high speed camera for whole field imaging. This experiment is capable of achieving strain rates on the order of 10^5 s^{-1} . Experiments at these strain rates have shown substantial plastic deformation without failure when compared with the lower rates of loading. This is evidence of deformation mechanisms that tend to delay failure in the material. We also observe a change in the hardening rates between these experiments and experiments done at 10^3 s^{-1}. Examination of the microstructure of deformed samples gives us information about the relative activation and growth of deformation mechanisms that cause plastic deformation at these rates.