TECH Notes

Hot-Rolling Studies on the UMT

A Tool-within-a-Tool for Hot-Rolling Related Studies

TN1000 Rev. A0

Introduction

The UMT is a modular, versatile mechanical tester capable of simulating a vast number of real-life industrial applications. This tech note shows how the UMT can be used to simulate hot rolling of aluminum. As in any bench top simulator, one must thoroughly understand the full-scale mechanical mechanism before beginning to scale down sample geometries.

Materials

Aluminum samples with dimensions of roughly 35mm x 10mm x 10mm were placed inside a 1000°C reciprocating stage on a UMT system. A passively rolling sample with a diameter of 12mm was used as an upper sample (see Figure 1).

Methods

Three lower aluminum samples were heated to various temperatures ranging from 450°C to 550°C under an inert gas environment. Two of the three samples were run in a forward and then reversed direction so that the same path was passed over. One sample was run only in one direction. The upper passively rotating roller was lowered to either a load of interest or a displacement of interest. The UMT can operate in either load-control (2000N max) or displacement-control modes. A mixture of water and lubricant was applied to the lower sample. Immediately following, the lower sample was moved under the roller causing a certain path of deformation. The deformed sample is shown in Figure 2.

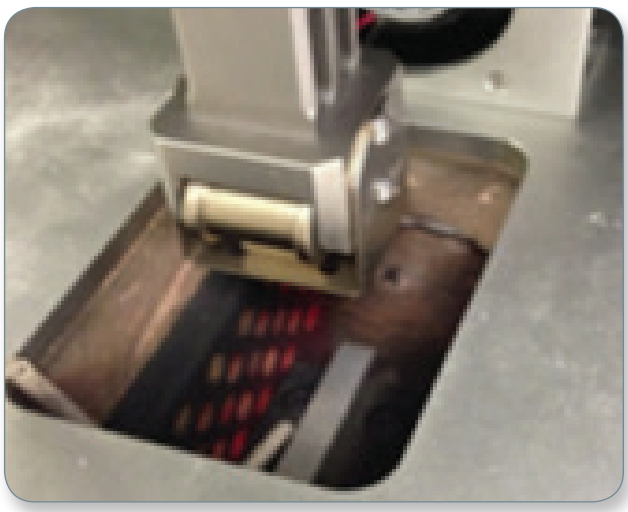

Figure 1. Passive roller system used for simulation of hot rolling.

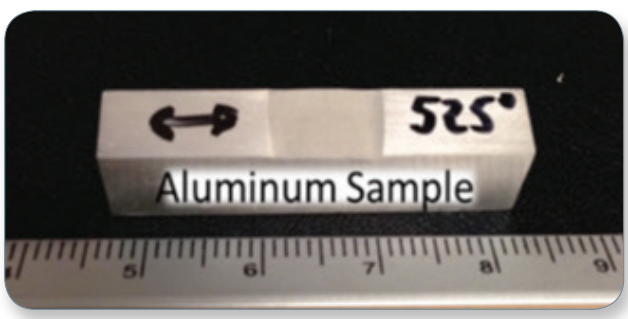

Figure 2. Lower sample after deformation.

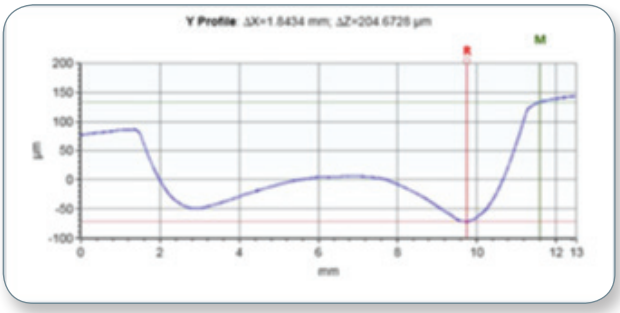

Figure 3. Profile along rolling direction of aluminum sample.

A Bruker white light interferometry (WLI) instrument was used to examine the deformed region. Figure 3 shows a profile of the deformed region.

Throughout the simulated rolling step, several parameters were monitored. These included temperature of the sample, Z position of the roller within 2µm, normal load, and frictional force (resistance to rolling). These channels can be acquired at several kHz per channel and plotted in the UMT viewer software. A typical plot of these experiments is shown in Figure 4.

Analysis:

- The COF, or resistance to rolling, increases with temperature, due to deeper penetration of the roller.
- Reverse-stroke passes were observed to have a lower COF.

While under force control the pause at the beginning and end of the stroke resulted in deeper "indentations" that were likely from material creep.

Conclusion:

The UMT is an excellent option for helping to understand the hot rolling process in a laboratory setting. All parameters can be set and controlled very precisely. Load can be controlled to microNewtons, sample temperature to ±1° centigrade, position to within 1µm. The flow rate of inert gas can be controlled, as well. All of these parameters are easily set and managed from within the UMT software.

Companies that could benefit from this type of system:

- Companies doing metal rolling
- Manufacturers of rolling lubricants
- Roll makers

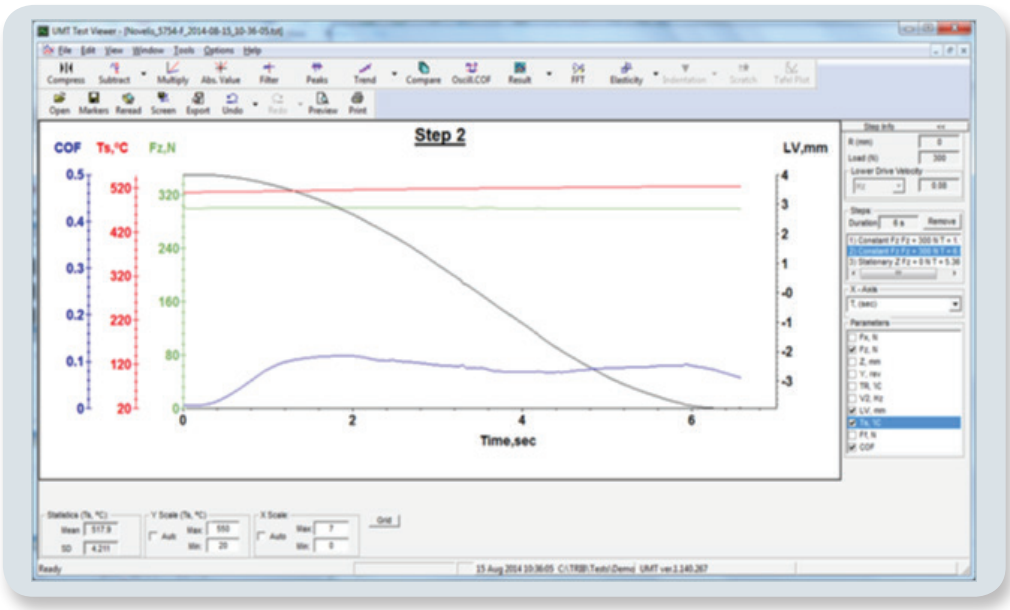

Figure 4. UMT viewer software plotting all critical parameters of one step of simulated hot rolling of aluminum.

Bruker Nano Surfaces Division

Campbell, CA • USA
Phone +1.408.376.4040/866.262.4040
productinfo@bruker.com
www.bruker.com/nano