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Topographical characteristics of Twin Roll Cast aluminum strip surface and its evolution with rolling

Murat DÜNDAR,

Assan Aluminum, İstanbul

murat.dundar@assanaluminyum.com

ABSTRACT

Twin roll casting (TRC) is the continuous production of strip from the molten metal in one process that involves solidification and deformation in between two water cooled rolls. Surface topography of the rolls changes with increasing amount of materials cast due to build-up of aluminum/aluminum oxide and cracks created by thermal and mechanical loads exerted on the rolls. These features are imprinted to the sheet surface and impair the surface quality. While the as-cast sheet is exposed to cold rolling, topography of the surface deforms by leading to smeared thin layer to be formed over the micro valleys. Thin layers readily dislodge and resulting in aluminum fines to be formed. Surface characteristics of as-cast material and its evolution with cold rolling passes were investigated. As-cast surfaces were characterized by employing SEM and roughness measurements. Change in surface features of the sheet with increase in cast material tonnages were also investigated.

RESULTS

Study was conducted on typical alloys that are commonly produced by employing TRC technology, namely AA8006 and AA3003. Topographical features of the as-cast sheets were investigated with SEM studies. Representative samples from the first cast coil and progressive ones were gathered to observe gradual change on the surface topography and roughness. Figure 1 (a) and (b) show surface of the as-cast sheet in the first coil of the casting operation and after casting of 480 tons. Note that weight of each coil is 10 tons.

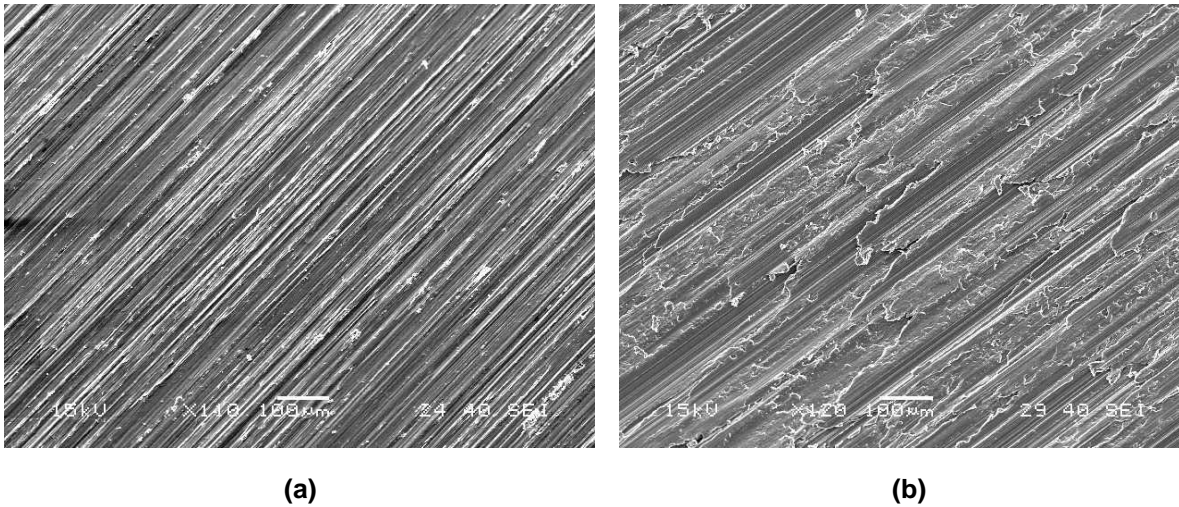


Figure 1. Surface of the as-cast sheet in the first coil (a) and after casting of 480 tons (b).

Another study was also carried out on the caster roll surface if there exists any topography developed in time that contributes to generation of such features on the sheet surface. It was confirmed that with the increase in casting tonnage, significant amount of aluminum-aluminum oxide builds up at particular positions such as at transverse cracks appeared on roll surface. The position of transverse cracks are perpendicular to the casting direction (Figure 2).

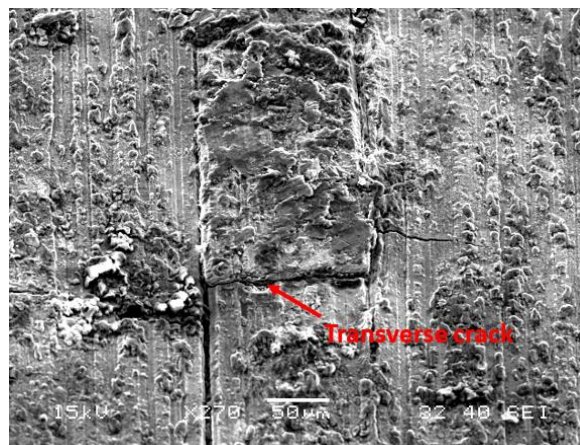


Figure 2. Transverse crack on the roll surface and material build-up.

While these industrial size coils were being rolled in cold rolling mill, mill was stopped abruptly and another set of samples were created that show change in surface features starting from as-cast surface to deformed area in between the roll gap. It is clearly shown that severe roughness on the sheet is flattened out. Peaks are smeared towards the adjacent gorges. Even after one rolling pass, as the surface progressively observed from the as-cast area to the reduced thickness, all the gorges are filled with the material next to them (Figure 3).

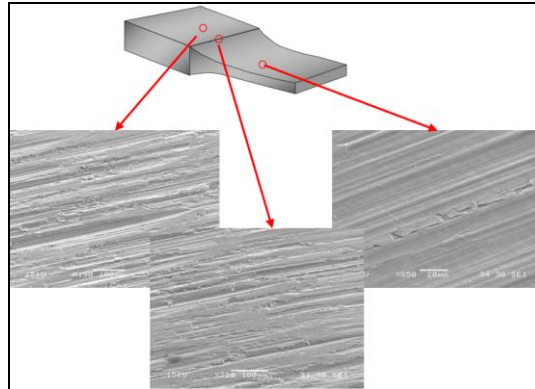


Figure 3. Change in topographical features of as-cast sheet in the first rolling pass.

More rolling passes applied to the material do not contribute to adherence of this thin metal layer to the bulk. Thus, it becomes thinner and dislodged from the surface even by small mechanical agitation. These aluminum fines are identified as “smut” in aluminum industry and can be a source of major issues in some application, for example, impairment of the adhesion of lacquer, accumulation on the die surfaces and transfer to the article to be produced [1-2]

It was shown that, regardless of the aluminum alloy, some fundamental issues implemented during production remarkably reduced the smut generation. They include, casting of the sheet at critical thickness, proper design of thermomechanical processes and rolling oil management.

REFERENCES

- [1] Januszkiewicz, K.R., Stratford G., Ward T., 1994, “Roll bite conditions controlling formation of wear debris during cold rolling of Aluminum”, *J. of Mater. Process Tech.* (45), 117-124.
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KEYWORDS

Twin Roll Casting (TRC), Aluminum alloys, Cold rolling, Wear debris