ISOThermal Grain Growth in Strained Commercial 2S Aluminium

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ABSTRACT

In an attempt to study the effect of grain size on the low temperature plastic flow characteristics of Indian commercial aluminium, it was found necessary to determine the thermal treatments that produce the desired grain size. The recrystallization-anneal technique was employed and the present communication summarizes the results obtained.

MATERIALS AND TREATMENT

Rolled sheets of commercial 2S aluminium, 2.5 mm in thickness, were used. The average analysis as reported is 99.57 Al, with Fe and Si as the chief impurities. Strips of size 10 mm \times 50 mm were cut from the as-received sheet and annealed for 1 hr at 450°C. The initial grain size in all the samples (about 500) was checked and found to be uniform at 0.03 mm. The annealed specimens were strained plastically by pulling in tension in a universal testing machine at a rate of 1 mm/min. The amount of pull on the machine was calibrated to result in permanent plastic strain in the samples in steps of 1% up to a maximum of about 30%, at which fracture occurred. The strained samples were then annealed in a muffle furnace at a temperature of 400°C for periods up to 24 hrs. No etching was done prior to annealing. At the end of the annealing period the specimens were withdrawn and cooled in still air. Tuckers etchant was used to etch the samples by swabbing until the grains were just revealed. Grain sizes were measured under
the microscope at suitable magnifications. Hardness values were recorded on a Vicker’s Hardness Tester using 1 kg load.

RESULTS AND DISCUSSION

Figure 1 shows the effect of pre-strain on the grain size in the annealed commercial aluminium for three different annealing periods, viz., 6, 12 and 24 hrs. The data presented in Fig. 1 are obtained from 20 sets of samples, and it is apparent that the results are reproducible. This was further checked by selecting single random values of strains and performing the tests. The critical strain for extensive grain growth is 14–15% as against 2–3% in very pure aluminium. This difference will have to be attributed to the presence of the impurities. By controlling the pre-strain in the range 14–30% it is possible to obtain any desired grain size in the range 0.05 to 15 mm.

The grain size is not very sensitive to the annealing period; it only slightly increases with increasing annealing period, for strains greater than the critical strain, while at lower strains it is unaffected.

In the region of critical strain, no grain boundaries were visible in the gauge length of the specimen. In these cases the grain size developed was taken as that between the first visible grain boundary near the top and bottom grip marks. It is possible that in larger samples, this value is influenced.

Figure 2 shows a plot of hardness (VHN) vs. grain size in these samples. A Hall-Petch type relation was tried for fitting the hardness data. It was found that for lower grain sizes, the hardness values were scattered about a straight line of the type:

$$H = H_0 + k \sqrt{d}$$  \hspace{1cm} (1)

with $H_0 \approx 23$ and $k \approx 1$–2. Thus in commercial aluminium also the Hall-Petch equation may be obeyed, but a more rigorous check would be possible only if the yield point data, especially those obtained at low temperatures, are available.

It may also be noted that in Fig. 2, the hardness of specimens with large grain sizes is surprisingly higher than that predicted by equation (1). One would normally expect the hardness to be lower. This again seems to be a peculiar feature in commercial aluminium. In the present study the different grain sizes were obtained by straining and annealing. Thus, the deviation observed in large grain sizes is probably associated with the dislocation struc-

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**FIG. 1. Variation of post-anneal grain size in commercial 2S aluminium as a function of pre-strain (%), Annealing temperature: 400°C.**

**FIG. 2. Variation of hardness (VHN) as a function of grain sizes in strain-annealed commercial 2S aluminium.**
bronze and copper the Hall-Petch relation was observed to hold good for values of \( d^{-1} \) greater than 1.5 mm\(^{-1} \). In the present study also it is found that the VHN values are linearly related with \( d^{-1} \) (mm\(^{-1} \)), for values greater than 0.5.

In order to give an unequivocal explanation as to the observed anomalous behaviour, it is necessary to make a deeper study of the dissolution structure in coarse-grained commercial aluminium.

**CONCLUSION**

A critical strain of 14-15% is necessary for extensive grain growth in commercial 2S aluminium. There exists the possibility of growing single crystals by the recrystallization-anneal technique in this material. Hardness and grain size may be related by a Hall-Petch type equation. The specimens with large grain size show significantly higher hardness.

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**PARTHENIUM WEED IN MYSORE STATE AND ITS CONTROL**

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**WHITE** top (*Parthenium hysterophorus* Linn.), a member of Compositae, is a native of tropical America. It is reported to be widely held that the seeds of this weed came to India with grains imported from U.S.A. or Canada. In India, the weed was first pointed out in Poona (Maharashtra) by Prof. Paranjape in 1951, as stray plants on rubbish heaps and was reported by Rao in 1956, as a new record for the country. Since then it has spread to Kashmir, Delhi and Madhya Pradesh.

In 1961, Ladwa and Patil recorded this weed as a rare plant from Dharwar (Bombay Karnatak region) and so far the weed does not seem to have been reported from any other part of Mysore State. The author has observed the weed in pure dense stands in Bangalore, Mysore, Arasikere, Birur, Bhadravathi, Shimoga and many other stations on Bangalore-Talaguppa railway line. Specimens collected from these regions tally well with descriptions given by Rao and Maheshwari. Considering its spread and abundance the weed may be said to have invaded these regions about six years ago. It inhabits goods shed areas, slopy sides of railway track, roadside, edges of canals, wasteland and new construction sites. Similar habitats have been reported for the weed from other parts of India.

Transport seems to be the sole means of dispersal of the weed over long distances. The weed produces alarmingly large number of small fruits which with the help of the two spongy pads attached to their body can very efficiently be disseminated locally by wind and water.

The seedlings come up in abundance in the early monsoon period. The radical leaves spread radially very close to the ground over a considerable area allowing no other seedling to come up. By their vigorous top growth they can overtake any other species in their neighbourhood. They start flowering when about a month old and remain flowering and fruiting profusely for six to eight months. Thus, the prolificity and aggressiveness of the weed contribute a great deal to its quick spread and successful colonization.

Within about two decades the weed has become naturalised in many parts of our country. The gravity of the situation that would arise if the weed is left unchecked, is indicated by many workers. Vertak reported the weed as spreading like a wildfire in Maharashtra encroaching on cultivated fields and grasslands and that a piece of land yielding 9-10 C.L. of grass hardly yields a single C.L. due to this weed. It has also been a menace in forest nurseries. Shelmire (quoted by Maheshwari) has classed this weed among the top seven for their role in contact dermatitis. Its pollen is known to cause allergy. Parthenin, one of the constituent principles characterised, is known to act as a depressant on nervous system in human beings. If such