Sever Surface-Deformation of Alloys: Promising Approach to Enhance Properties

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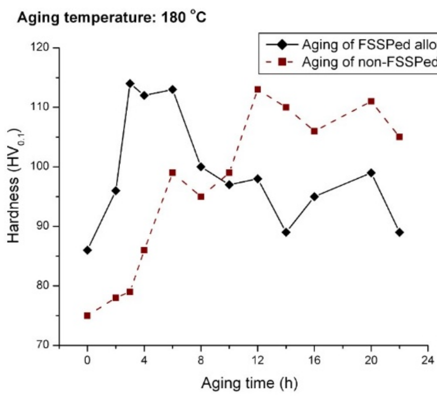

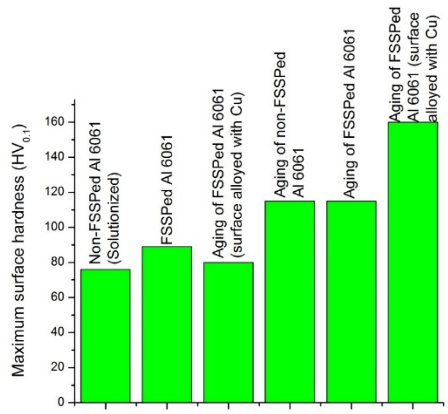

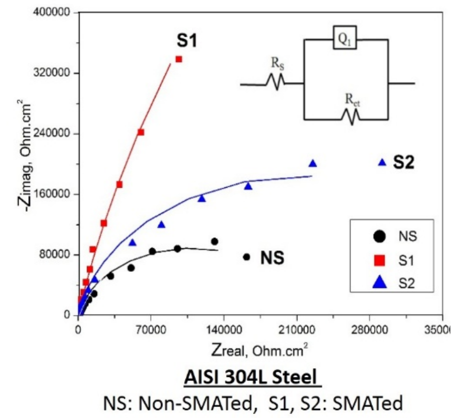

There are various engineering applications where surface must perform a job different from the bulk of a component. On many occasions, just by altering 1–2 % of the total thickness of the components, the properties enhance their performance considerably. In the last several decades, the importance of surface engineering has grown substantially. The list of applications requiring the manipulation of surface properties is unlimited, especially in the field of automobile, petrochemical, food processing, nuclear, etc. Sever plastic deformation (SPD) of surfaces is a promising approach to manipulate the surface microstructure and the properties. Friction stir surface processing (FSSP) and surface mechanical attrition treatment (SMAT) techniques process the surface of metals and alloys in the solid state. Properties of the alloys can be manipulated by varying the process-parameters.

As an example, the aluminium alloys are soft and have poor tribological properties. We have successfully enhanced the surface hardness of the heat-treatable Al-alloy using the combined approach of thermal-spray of Cu, FSSP and heat-treatment. FSSP enhanced the age-hardening kinetics. Using this approach, about 39% improvement in the surface hardness of the age-hardened Al 6061 alloy (where surface is alloyed with Cu using FSSP) was observed. This approach can also be extended to convert the surface of non-heat-treatable Al-alloys in to the heat-treatable and enhance surface properties.

In another approach, in-house developed SMAT setup enhanced the surface hardness and corrosion properties of austenitic (AISI 304L) and duplex (AISI 2205) stainless steels. SMAT refined the grains of the steels to a nanometer size and caused more than 100% improvement in the surface hardness. Surface response was dependent on the SMAT-parameters and steel-chemistry. Mechanical twins and deformation induced martensite phase were observed in the SMAT affected region of AISI 304L SS. SMAT improved the corrosion resistance and plasma-nitriding kinetics of the steels. Effective nitriding time (the difference between the actual nitriding time and the chemical etching time) and hence, the thickness of the nitrided layer were increased with increase in the duration of chemical etching (i.e., sputter cleaning step prior to plasma-nitriding) and a decrease in the stability of passive layer on the SMATed specimens. Surface hardness of the nitrided specimens was dependent on the formation of expanded austenite and its decomposition.

Further information on FSSP is available at https://doi.org/10.1007/s12666-018-1277-0