Stellite bearings for liquid Zn-/Al-Systems with advanced chemical and physical properties by Mechanical Alloying and Standard-PM-Route

Part I

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An important business-field of world-wide steel-industry is the coating of thin metal-sheets with zinc, zinc-aluminum and aluminum based materials. These products mostly go into automotive industry, in particular for the car-body, into building and construction industry as well as household appliances.
Due to mass-production, the processing is done in large continuously operating plants where the mostly cold-rolled metal-strip as the substrate is handled in coils up to 40 tons unwind before and rolled up again after passing the processing plant which includes cleaning, annealing, hot-dip galvanizing / aluminizing and chemical treatment.

In the liquid Zn, Zn-Al, Al-Zn and Al-Si bathes a combined action of corrosion and wear under high temperature and high stress onto the transfer components (rolls) accounts for major economic losses. Most critical here are the bearing systems of these rolls operating in the liquid system. Rolls in liquid system can not be avoided as they are needed to transfer the steel-strip into and out of the crucible.

Since several years, ceramic roller bearings are tested here [1,2], however, in particular due to uncontrollable slag-impurities within the hot bath [3], slide bearings are still expected to be of a higher potential [4].
The today's state of the art is the application of slide bearings based on Stellite?against Stellite which is in general a 50-60 wt% Co-matrix with incorporated Cr- and W-carbides and other composites.

Indeed Stellite is used as the bearing-material as of it's chemical properties (does not go into solution), the physical properties in particular with poor lubricating properties are not satisfying at all. To increase the sliding behavior in the bearing system, about 0.15-0.2 wt% of lead has been added into the hot-bath in the past. Due to environmental regulations, this had to be reduced dramatically. This together with the heavily increasing production rates expressed by increased velocity of the substrate-steel-band up to 200 m/min and increased tractate power up to 10 tons in modern plants, leads to life times of the bearings of a few up to several days only.

To improve this situation, the Mechanical Alloying (MA) Technique [5,6,7,8] is used to produce advanced Stellite-based bearing materials. A lubricating phase is introduced into Stellite-powder-material by MA, the composite-powder-particles are coated by High Energy Milling (HEM) in order to produce bearing-bushes of approximately 12 kg by Sintering, Liquid Phase Sintering (LPS) and Hot Isostatic Pressing (HIP).
The chemical and physical behavior of samples as well as the bearing systems in the hot galvanizing / aluminizing plant are discussed. Dependencies like lubricant material and composite, LPS-binder and composite, particle shape and PM-route with respect to achievable density, (temperature-) shock-resistibility and corrosive-wear behavior will be

described.
The materials are characterized by particle size analysis (laser diffraction), scanning electron microscopy and X-ray diffraction, corrosive-wear behavior is determined using a special cylinder-in-bush apparatus (CIBA) as well as field-test in real production condition.

Part I of this work describes the initial testing phase where different sample materials are produced, characterized, consolidated and tested in the CIBA under a common Al-Zn-system. The results are discussed and the material-system for the large components to be produced for the field test in real production condition is decided.

Outlook:
Part II of this work will describe the field test in a hot-dip-galvanizing/aluminizing plant of the mechanically alloyed bearing bushes under aluminum-rich liquid metal. After testing, the bushes will be characterized and obtained results with respect to wear, expected lifetime, surface roughness and infiltration will be discussed.

Part III of this project will describe a second initial testing phase where the won results of part I+II will be transferred to the Al-Si system.

Part IV of this project will describe the field test in a hot-dip-aluminizing plant of the mechanically alloyed bearing bushes under aluminum liquid metal. After testing, the bushes will be characterized and obtained results with respect to wear, expected lifetime, surface roughness and infiltration will be discussed.

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