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Development of the PVD ceramics coating and duplex treatment technology

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1.Introduction: Mainstream of surface treatment for Die and molds was high temperature dipping diffusion treatment and CVD before. These treatments make the molds shift its accuracy at high temperature, therefore the molds have to heat treatment again after surface treatment. PVD process is able to deposit of superior ceramics coatings in heatproof and wear resistance at low temperature. It is inferior to durability because the coatings by PVD process does not form strong diffusion layer like high temperature dipping diffusion treatment and CVD. We have greatly improved durability by duplex processing, nitriding and PVD process. And we developed an excellent coating to oxidation resistance and wear resistance, which is able to reduce the damage of molds.

2. Experimental methodology: A schematic diagram of the Cathodic Arc system is shown in Fig.1. The coating was deposited from Cr and Cr-Al alloy cathodes as a nitride ceramics.

3.Property of Cr-composite coatings

3.1 Physical property: Hardness of coatings was evaluated by Nano Hardness Tester(NHT:CSEM). CrAlN coating shows 3000Hv or more though the conventional TiN, CrN and TiAlN show from 2000 to 3000Hv. It shows quite high-hardness. Oxidation resistance was evaluated by TG-DTA. CrAlN coatings doesn't show a rapid oxidation at 1100°C though TiN and TiAlN shows a rapid oxidation at 500°C and 900°C respectively. Superior oxidation resistance of CrAlN was shown.

3.2 Tribological property at high temperature: Wear resistance at high temperature was evaluated by Tribometer THT1000(CSEM). CrAlN coatings kept 0.3 friction coefficient though CrN and TiAlN caused peeling off by the oxidation at 1000°C.

3.3 Performance evaluation: Performance of CrAlN coating was evaluated by cold backward extrusion press working. Uncoated, high temperature dipping diffusion treatment(TD process), CVD and duplex processing(nitride+CrN) punches were prepared. Cold backward extrusion press working was evaluated by Knuckle joint type 160t press system. Work-piece material was rolled steels for general structure(SS400, bonderized), and has been pressed 150shots so that the thickness of the bottom may become 2mm. The durability of each samples was evaluated according to the depth of the scratch at the end face of punch that occurs by having pressed. The depth of the scratch was shown in Fig.2

CrAlN coating had been kept smoothness on the surface of the punch, and was not able to observe the scratch. On the other hand, CrAlN coating was observed a blackish discoloration part different from another surface treatment. It was confirmed that this blackish discoloration part was the oxide layer, depends on the frictional heat. The oxidation behavior was gradual though it begins oxidizing from approximately 500°C.

It was thought that it functions as a barrier layer that prevents oxygen from it to the inside of the film from diffusing when the oxide layer is formed on the surface.

Under large load, CrAlN coating did not peel off and scratch at the end face of punch. In this study, it was confirmed that CrAlN coating is superior durability than conventional coatings

