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MOLD COATING

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FIELD OF THE INVENTION

The present invention is related to the molding industry. In particular, the present invention is related to the coating of molds. More particularly, this invention is related to a cavity bar and cull block for molding semi-conductor packages and method of using the same.

BACKGROUND OF THE INVENTION

IC packages comprise electrically insulating plastic material such as epoxy molding compound molded to protect the IC chip and die-leadframe assembly. The molding equipment includes a cavity bar containing a plurality of cavities which act as molds for the epoxy compound. During the molding process, the epoxy molding compound is injected into the cavities at high speed and temperature through an orifice or runner. The molding compound is then allowed to cure and solidify in the mold to form the packaging, followed by ejection of the package from the mold. Besides corrosive components, the epoxy molding compound generally contains about 70-80% filler which directly causes serious wear and stickiness on the cavity bar and cull block surface during preparation and subsequent molding process. As a result, the mold surface must be protected by a coating which protects the mold from corrosion, wear, and reduces the stickiness of the molded compound. In addition, grease, wax and oils are commonly present in the molding compound to facilitate the ejection of the molded package, and this results in the accumulation of a film of oily residue

that may affect the molding process. As a result, the molding process has to be stopped at regular intervals in order to clean the molding equipment after a certain number of molding or shots. The cleaning process typically involves manually administering melamine shots into the cavity bar. The melamine reacts with the oily contaminants which are removed after multiple melamine shots. Besides causing a loss in productivity due to the pause in the assembly line and the need for manual cleaning, melamine is carcinogenic and pungent.

The current method to overcome the above-stated difficulties is to coat the surface of cavity bar and cull block (hereinafter called substrate) with a corrosion and wear resistant material that alleviates the adhesion of the polymer and grease on the mold. A good coating material should have the following desirable properties : (a) High microhardness and high wear resistance to withstand the physical rigors of the injection, molding and ejection processes; (b) high adhesion strength to the substrate to alleviate peeling and detachment from the mold surface; (c) a smooth microstructure and low coefficient of friction to minimize the sticking of the epoxy compound and to facilitate ejection; and (d) a uniform microstructure which is free of bubbles and cracks.

The typical material used for such coating is flash chrome and titanium nitride. The advantage of flash chrome coating is that it has a high corrosion resistance and low coefficient of friction, allowing the cured polymer to be easily ejected. Flash chrome, however, does not have good microhardness, and also tend to give broken areas and gaps between the coating film and the substrate. As a result, wear-rate of flash chrome is high, and the coating

can easily peel off. Titanium nitride coating gives good microhardness and has generally desirable properties and improved wear-rate, but is very sticky due to its higher coefficient of friction. In addition, the cost of a titanium nitride coating is very high.

6 OBJECT OF THE INVENTION

It is therefore an object of the present invention to provide a coating to overcome some of the shortcomings as stated above.

It is another object of the present invention to provide a coating with good microhardness and microstructure at reduced cost.

12 SUMMARY OF THE INVENTION

The present invention provides a CrN coating for molds such as the cavity bar and cull block, and a method for using the same. The CrN coating may be of 1-10 μ m thickness. For the molding of IC packages, the CrN coating on the cavity bar and cull block is most preferred to have a thickness of 2 μ m to 3 μ m. The CrN is preferably deposited by physical vapor deposition (PVD).

DESCRIPTION OF THE INVENTION

The CrN coating of the present invention is most preferably deposited by the conventional physical vapor deposition (PVD) at a temperature of less than 500°C. A transitional layer of CrN₂ is preferably provided between the substrate and the coating to facilitate the adhesion of the coating to the
6 substrate. The CrN coating may have a thickness of 1-10µm. The preferred thickness is 2-5µm. The most preferred thickness for coating a cavity bar and cull-block is 2-3 µm.

Standard methods of molding may be used with the CrN coated molding of the present invention. For example, Epoxy molding is injected at 175°C into the cavity under 2500psi clamp pressure. Transfer pressure is 1233 psi
12 with a cure time of 80 seconds. Under these conditions, approximately 1,000 shots may be administered before cleaning has to occur. For the cleaning of CrN coated cavity bars, the typical cleaning regiment with melamine may be used. This includes a transfer pressure of 800psi and a cure time of 200 seconds. However, the number of shots may be reduced compared to flash chrome coatings to achieve a similar degree of cleaning.

18 Table 1 is a comparison of Surface treatment between flash chrome and CrN. Test results show that PVD-CrN coating gives even, consistent and uniform microstructure, excellent adhesion strength between coating film and substrate, high microhardness (HV>1800), high wear and corrosion resistance, stable dimension, good non-stick properties and low coefficient of friction.

Due to these improved characteristics, the number of mold shots which can be administered in a CrN coated cavity bar between cleaning may be increased to twice the number in a flash chrome coated cavity bar. In addition, due to the exceptionally smooth, non-stick surface of the CrN coating resulting in lower amount of contaminating residues, the number of cleaning shots may also be reduced, even with the extended usage. This is summarized in Table 2 below.

	Flash Chrome	CrN
Frequency of cleaning	1 time per day	1 time per 2 days
Number of cleaning shots	7-9 shots per time	5-6 shots per time

Table 2

While the present invention has been described particularly with emphasis on a coating for molds for IC packages, it should be understood that the examples are for illustration only and should not be taken as limitation on the invention. In addition it is clear that the method and coating of the present invention has utility in many applications where protection of a mold surface is required. It is contemplated that many changes and modifications may be made by one of ordinary skill in the art without departing from the spirit and the scope of the invention described.

Table 1 Comparison of Surface Treatment between Flash Chrome and CrN

Facilities & Properties	Surface Treatment	
	Flash Chrome	CrN
Equipment	Generator, Rectifier, Alternating Current, Anode, Tank, Temperature & Time Controller and Indicator etc.	Current Power, Cleaning Tank, Vacuum Furnace, Source of Electron Beam and Source of Plasma etc.
Fundamental Theory	Electronic-Chemical Process	Physical Vapor Deposition (Atom Bombardment)
Tooling & Fixture	Simple	Copper Rod and Magnet Rod etc.
Coating Material	Solution (Effect period is limited).	Solid as an ingot and the combined gas.
Plating Temperature	40 - 60°C	400 - 500°C
Process Flow	Cleaning - (Etching) - Flash Chrome - Rinsing - Checking	Cleaning - Preheating - Ion Etching - Coating - Checking
Microstructure	There are some broken areas and gaps between film and Substrate.	Even, Uniform and Consistent Film (Columnar Structure)
Plating Thickness	2 μm - 0.1 mm	1 μm - 10 mm (Excellent Accuracy)
Surface Finishing	Roughness of EDM surface is not stable.	Roughness of EDM surface is almost stable.
Surface Defects	Uncoated area, Peel off, Stain Marks, Flaking, Chip off and Spider Cracks etc.	Uncoated dots and droplets etc.
Microhardness	HV > 1000	HV > 1800
Adhesion Strength	> 7000psi	> 10000 psi (Coating mat'l can penetrate into the substrate)
Wear Resistance	Less than CrN (Lower Microhardness and higher coefficient of friction)	Much better than Flash Chrome
Corrosion Resistance	Less than CrN (Microstructure is not consistent)	Better than Flash Chrome
Coefficient of Friction	0.80 - 0.90	0.30 - 0.40
Non - Sticking Property	Worse than CrN	Much better than Flash Chrome (Synthetically properties of higher wear resistance and lower coefficient of friction)

CLAIMS

1. A mold for IC packages comprising a substrate and a CrN coating;
said substrate further having a transitional layer of CrN₂ between said
5 substrate and said CrN coating;
said substrate further comprising a cavity bar and a cull block for
molding of an IC package;
said CrN coating is deposited by physical vapor deposition.
- 10 2. A mold according to claim 1 wherein the CrN coating is 1-10μm
thick.
3. A mold according to claim 1 wherein the CrN coating is 2-5μm thick
- 15 4. A mold according to claim 1 wherein the CrN coating is 2-3μm thick
5. A method of molding an IC package using a molding system
comprising a substrate and a CrN coating, said substrate having a
transitional layer of CrN₂ between said substrate and said CrN
20 coating, said substrate further comprising a cavity bar and a cull
block, said method comprising the steps:
 - a) injecting molding compound into said cavity bar and cull block;
 - b) clamping said cavity bar;
 - c) curing said molding compound; and
 - 25 d) ejecting said molded package from said cavity.