SM&RT Multi-Ply Technology

Royal Canadian Mint
Monnaie royale canadienne

A SM&RT Story

Our multi-ply technology is unique. It delivers coins that offer superior quality, durability and security compared with other plating alternatives.
And as a cost-effective solution, it also delivers significant financial savings for our clients.

Most of all, it produces coins that are as distinctive and unique as your country.

BACKGROUND

Multi-ply plating was developed and patented by the Royal Canadian Mint, making its entry onto the Canadian market in 2000. Today, this proven technology enjoys success all over the world and has been adopted by some 28 different countries, including Canada.

28 COUNTRIES WITH MULTI-PLY PLATED TECHNOLOGY

Country	Year of Implementation	Country	Year of Implementation
CANADA	2000	ANGUILLA	2008
EL SALVADOR	2000	ANTIGUA AND BARBUDA	2008
NICARAGUA	2000	BARBADOS	2008
BOLIVIA	2001	COMMONWEALTH OF DOMINICA	2008
LEBANON	2002	DOMINICAN REPUBLIC	2008
PAPUA NEW GUINEA	2002	FIJI	2008
ECUADOR	2003	GRENADA	2008
UGANDA	2003	MONTSERRAT	2008
ETHIOPIA	2004	OMAN	2008
PARAGUAY	2004	ST KITTS AND NEVIS	2008
VENEZUELA	2005	ST LUCIA	2008
NEW ZEALAND	2006	ST VINCENT & GRENADINES	2008
BAHAMAS	2007	GUYANA	2009
GHANA	2007	PHILIPPINES	2009

Total number of multi-ply plated coins/blanks in circulation worldwide: 12.85 billion

SM&RT FACTS

BENEFITS OF MULTI-PLY TECHNOLOGY

- Increased security thanks to unique EMS for each coin
- Reduced costs compared with traditional alloy-based materials
- Unrivalled durability thanks to a dual anneal manufacturing process
- Extreme resistance due to different metal grains in layers
- Environmentally friendly manufacturing with a cyanide-free process

"The Canadian Mint impressed us with their quality of coins, in particular their durability and their electromagnetic signature, which is important for the vending industry. The Mint has an excellent reputation and extensive experience in making plated steel coins for Canada."

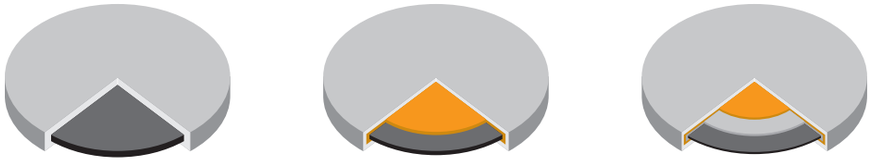
Mike Hannah, Head of Communications, Reserve Bank of New Zealand

SM&RT TECHNOLOGY

The Royal Canadian Mint's multi-ply technology is the most advanced plating process in the world. It consists of thin, alternating layers of metal that are electroplated to the steel core of a coin blank, creating a single super lattice with a reliable electromagnetic signature.

Red coins are made using a two-layer process. The first layer is nickel and the second is copper. White and yellow coins are made with a three-layer process. For white coins, nickel is layered first, followed by copper and then another layer of nickel. For yellow coins, the final layer is either brass or bronze.

COMPARISON MONO-PLY VS BI-PLY VS MULTI-PLY



Mono-ply
Nickel/Copper
on steel core

Bi-ply
2 layers of metal
covering steel

RCM Multi-Ply
3 layers of metal
on steel core

SM&RT FACTS

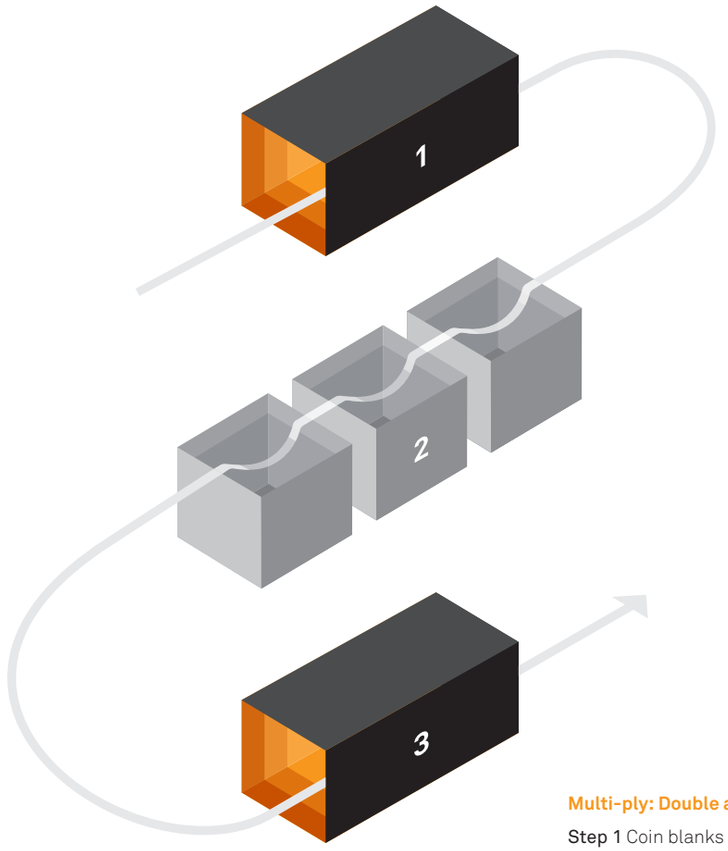
MONO-PLY VS MULTI-PLY

Mono-ply plating	Multi-ply plating
1 layer of metal coating steel core	3 layers of metal coating steel core
Single anneal	Double anneal
Inferior durability (micro-hardness)	Superior quality and durability
Longer manufacturing time	Shorter plating time
More expensive	Less expensive
Wide EMS	Narrow, targeted EMS
Low security	High security

THE MULTI-PLY PLATING PROCESS

Multi-ply coins are manufactured using a unique process that delivers the most durable and consistent plated products on the market.

One of the key innovations of the multi-ply process is its reliance on two separate heating stages. The first annealing process is used to soften the core of the coin. The second stage, meanwhile, helps relieve the mechanical stress in the plating layers while retaining the crystalline hardness of the outer nickel layer. This combination of pre-anneal and post-anneal processes delivers unrivalled durability (micro-hardness): typically, a finished multi-ply product has an outer layer that is around 1.5 times harder than a mono-ply coin.



Multi-ply: Double anneal process

Step 1 Coin blanks go through pre-annealing at 890°-900°C to soften and clean the blanks

Step 2 Plating

Step 3 Post-annealing at 450-550°C to remove plating stress

SM&RT RESISTANCE

One of the most important benefits of our unique manufacturing process is that multi-ply coins are more resistant.

In a mono-ply nickel-plated coin, the layer of nickel has a single metallic grain structure that is dendritic. It is therefore much more prone to pitting. In multi-ply coins, the grain structures and sizes of the different layers are dissimilar and therefore offer more resistance to penetration caused by abuse or general wear and tear. Furthermore, the nickel layers in our coins are columnar and the copper layer is laminar – which creates a highly effective barrier against corrosion. Thanks to these built-in design features, our coins have a life cycle of at least 25 years under regular usage conditions.

SM&RT FACTS

HIGHLY RESISTANT COINS

- Corrosion resistant to tropical humidity at ambient temperatures
- Corrosion resistant to household products
- Resistant to wear – 25 year minimum lifespan under regular usage conditions.
- Resistant to tarnish for nickel-plated steel in both hydrogen sulphide and sulphur dioxide atmospheres
- Passes artificial sweat test and cycle test with exposure at 100% relative humidity

LABORATORY TESTS

In order to ensure the highest standards for our coins, we frequently subject our products to in-market testing and scrutiny by independent laboratories. These studies have consistently shown that our multi-ply coins are more durable and resistant than traditional alloy and mono-ply coinage.

PRE-ANNEAL

Material	Hardness (R30T Scale)
RCM Multi-ply nickel plated steel	27-30
Cupro-nickel	30-33
Nickel	33-38
Mono-ply plated steel	47-50

POST-ANNEAL

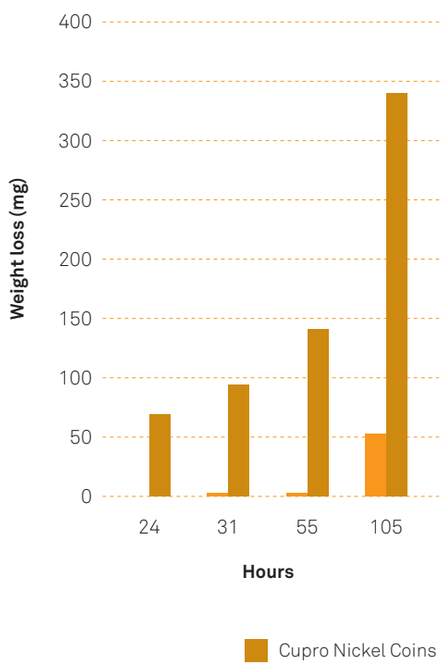
Material	Micro-hardness (Vickers Scale)
Cupro-nickel	152
Nickel (pure)	157
Mono-ply nickel plated steel	159
RCM Multi-ply nickel plated steel	229

"Multi-ply nickel-plated steel shows the least sign of wear at any time compared to cupro-nickel and mono-ply nickel plated steel in blank form or coin form."

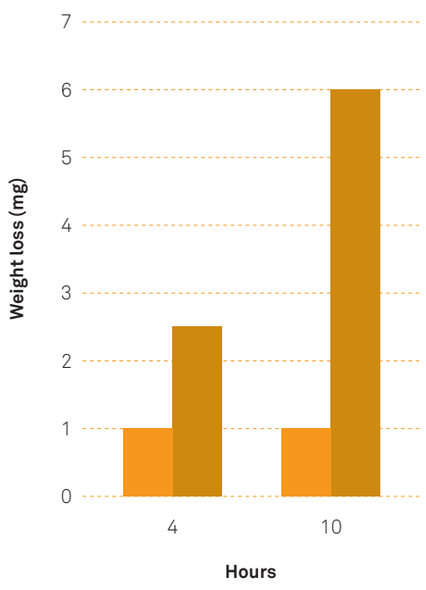
Kasetsart University

A typical in-lab test is the Rotary Tumbler Wear Test, which simulates a coin's circulation environment. Coins are placed inside a tumbler, where they slide against each other and come into contact with various pieces of fabric. Periodically, they are removed and measured to assess wear. At the same time, they are compared to circulation coins sampled from the marketplace, to provide a baseline to actual wear in everyday use. As per the graphs below the tests show that, over time, multi-ply plated steel coins display significantly less weight loss than alloy coins. In other words, multi-ply coins are considerably more wear resistant.

MIX OF 20 MULTI-PLY AND ALLOY COINS IN ROTARY TUMBLER TEST



SEPARATE TESTS OF 20 MULTI-PLY AND 20 ALLOY COINS IN HEXAGON TUMBLER TEST



RCM has also conducted a series of durability and wear tests in real-life situations. In extremely harsh coinage environments, such as certain African countries, coins may be exchanged up to 20 to 30 times more than in other countries. Even in this situation, studies show that multi-ply plated steel coins show less wear than mono-ply plated steel and alloy coins in the same environments.

SM&RT SECURITY

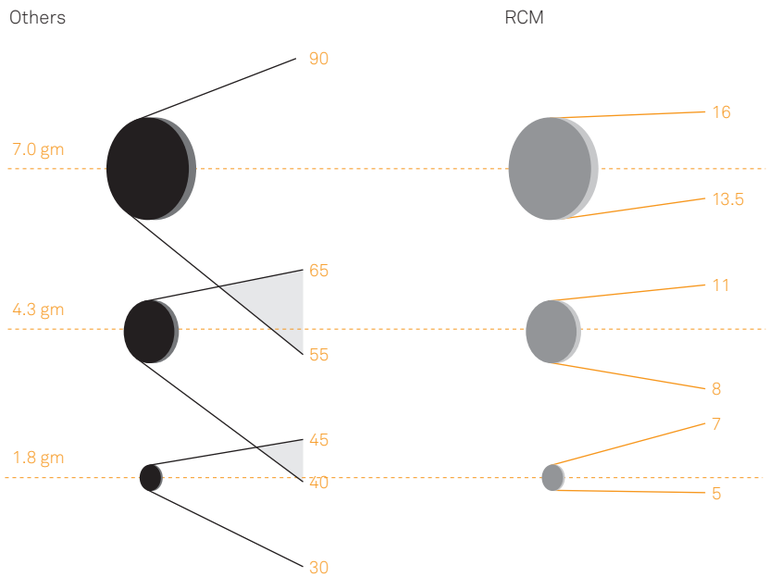
Compared with other plating technologies, the multi-ply process also produces coins that are more secure.

A coin's security is defined by its electro-magnetic signature (EMS). Each coin has an upper and lower range EMS, which is determined by the coin's size and metal composition. EMS is notably used by the vending industry to recognize a coin's value when it is inserted into a machine.

In mono-ply coins, the electro-magnetic signature covers a broad range, meaning there is a possibility of overlap between different countries and currencies – especially for coins of the same diameter. This can lead to problems of fraud, improper use, and contamination from foreign coinage.

In multi-ply coins, however, the relative thickness of individual plating layers can be altered to ensure that coins have a much narrower EMS. In this way, even coins of the same diameter have significantly different signatures. The net result is that multi-ply coins can be securely recognized and accepted by all manner of vending machines, public telephones, parking metres, public transportation systems and entertainment facilities.

COMPARISON OF EMS RANGES BETWEEN MONO-PLY AND MULTI-PLY COINS



"Gemsys is very pleased with the EMS technology plated on Canadian circulation coins. It has dramatically improved the acceptance rate through our equipment and has deterred people from inserting fraud/non-conforming items into our client's machines, thereby allowing tokens and washers with no value to fall through without providing credit."

Jack Lord, President, Gemsys Money Handling Systems Inc.

EMS SECURITY

- Multi-ply technology offers superior EMS readability
- In mono-ply coins, the wider range of EMS can lead to overlap, whereby two coins have the same signal
- In multi-ply coins, the conductivity of layered nickel and copper helps tighten the EMS range, eliminating the potential for overlap and currency mistakes.

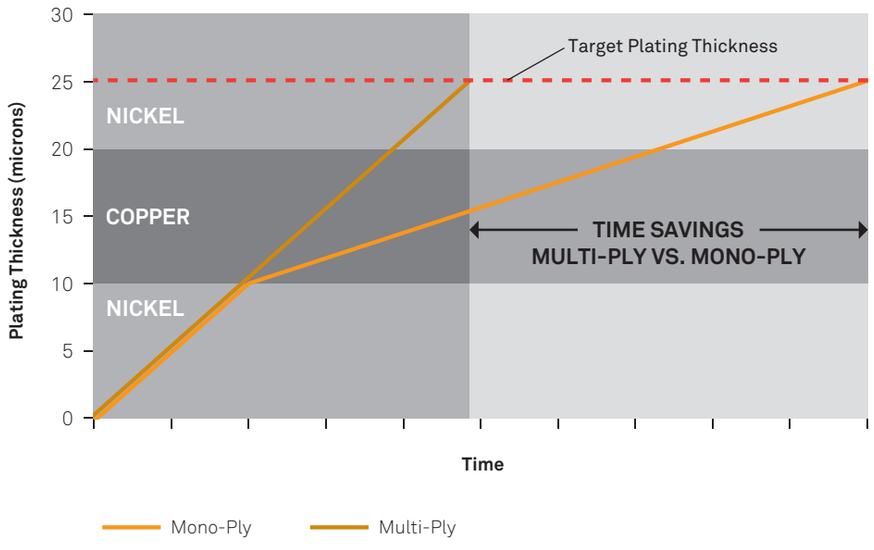
EVOLVING SECURITY FEATURES

At Royal Canadian Mint, we are continuously working to improve coin security and prevent fraud. Thanks to the diligent work of our engineers, scientists and technical specialists, our coins regularly offer innovative new features that make counterfeiting ever more difficult. Over the years, we have delivered a number of "World's First" security features, and we are continually striving to strengthen our acknowledged position as a leader in coin security and innovation.

SM&RT COST-EFFECTIVENESS

Multi-ply technology allows the Royal Canadian Mint to create less expensive coins by minimizing the amount of expensive base metals required. Only 6% of our coins' total weight is made up of expensive metals (94% is steel), meaning production costs are protected against the volatile metal markets and the ever-increasing costs of base metals. Depending on the size and weight of the coin, our clients typically save between 55 and 60% – with no loss of quality.

Furthermore, the multi-ply manufacturing process allows us to achieve the required plating thickness within 60% of the time required by mono-ply technology. For our customers, this translates into faster deliveries and lower costs. In Canada, for example, the government has saved over $250 million since converting from nickel alloy to multi-ply technology in 2000.



The lower cost of production also provides opportunities for seigniorage and revenue generation for governments. Once again, Canada is a case in point: since the Royal Canadian Mint began issuing multi-ply coins in 2000, Canada has realized more than $10 million annually in additional seigniorage.

"The Department of Finance is pleased to confirm its satisfaction with the... multi-ply plating used by the Royal Canadian Mint to make Canadian circulation coins... The use of this innovative material has resulted in significant savings for the Government of Canada... with no reduction in quality or finish durability from the alloyed material."

Rob Stewart, Director, Finance Markets Division, Financial Sector Policy Branch, Department of Finance Canada

SM&RT ECOLOGY

Unlike other copper, bronze and brass processes, multi-ply plating does not require the use of cyanide. The Royal Canadian Mint is therefore proud to offer its customers an ecologically-friendly manufacturing process, and a finished product that does not harm the global environment.

The Mint also has a comprehensive Environmental Management System, which carefully and consistently monitors environmental performance to ensure that all emissions – including noise, stack and wastewater – fall safely below regulatory norms set by the Canadian Environment Protection Act.

THE SM&RT DECISION

The Royal Canadian Mint's facility in Winnipeg is a powerhouse for high-volume production of plated blanks and multi-ply coins. Thanks to the industry's most technologically advanced processes and equipment, the overall production capacity of the Winnipeg branch exceeds 3 billion plated blanks annually – in a wide range of sizes, shapes and weight configurations. This capacity will increase significantly in the near future as a result of expansion throughout the Winnipeg production network.

> "...the Canadian circulation coins in the denominations of 1, 5, 10, 25, and 50 cents are produced by the Royal Canadian Mint using a multi-ply plated material and there have been no complaints, with respect to the quality of the coins from the banking community....In addition the Mint ensures that our members' requirements are considered in the production, shipping inventory control and marketing of circulation coin products within Canada."
>
> *Raymond J. Protti, President & Chief Executive Officer, Canadian Bankers Association*

On top of our unique multi-ply technology, we offer a wide range of products and services, including dies, die coatings, master punches and tooling, plus roll and wrap and other coin packaging. Across all these fields, we are committed to high quality in design, materials, workmanship, delivery and security – and to producing coins that are as unique and distinctive as your country. Whatever your coinage needs, we believe that partnering with us is the smart decision.

SM&RT FACTS

OUR FACILITY

- 15 million plated coins produced daily
- 41 high speed coining presses
- 2 electroplating lines featuring 39 process stations
- 180 000 blanks inspected hourly

SM&RT vision

SM&RT is a promise that your country's story is in safe hands. Thanks to its distinctive blend of innovative technology and skilled craftsmanship, SM&RT delivers coins that, like your country, have a unique identity. And that means you can have complete peace of mind.

SECURE, MODERN & RESISTANT TECHNOLOGY