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Glass that Will Change the World: The Use of Glass Containers in the International Shipping Industry

Imagine a new technology that could dramatically reduce the threat of international terrorism, human trafficking, and illegal transport of contraband goods. We believe that using this 50X stronger glass to construct containers used by the international shipping industry will do just that. The international shipping business is a \$100 billion dollar industry that represents more than 90% of world trade and is growing in volume by more than 10% per year. Even though this industry is critical to the world economy, and without it the import and export of necessary food, supplies, and other goods would not be possible, the industry is vulnerable to threats of international terrorism and human rights violations because current steel containers are rarely searched thoroughly at international checkpoints.

Every year, over 200 million containers are shipped globally, each measuring approximately 8 x 8.5 x 40 feet in size and weighing 4000 kilograms. The containers are built out of steel and consequently their contents are difficult to quickly and efficiently examine at security checkpoints. Not only may dangerous goods be transported on cargo ships, but also there are estimates of more than 1 million people are transported in human slavery each year, with an unknown number traveling by cargo ship. It is therefore necessary that dramatic improvements need to be made in shipping security for the safety of the international community.

According to current estimates, only a very small percentage (2% in the United States, 7% in Australia) of containers in ports internationally are inspected by security at departure and arrival. To eradicate this problem, scientific researchers have focused on developing expensive new technology that would allow inspectors to be able to see through the steel containers. We believe that a far simpler and much more economical solution is to make the shipping containers themselves transparent. The 50X stronger glass would make this possible, thereby allowing for simple visual inspection of containers at every departure and arrival port around the world. In addition to its tremendous profitability, we also believe that this application represents major security, industry, and environmental benefits.

International Security

Current security methods at ports around the world are limited in scope and in execution. Security officials rely on randomly selecting several containers for thorough manual examination; the remaining containers on the ship go unchecked. At best, current technology enables searchers to probe the contents with X-rays and radioactive monitors, but these processes are slow (10-15 minutes per container), expensive, and have limited accuracy. Shipping containers that are instead made out of 50X glass (see Figure 1) would dramatically improve the basic visual search and the properties of glass would work well with X-rays, radioactive monitors and also newer identification technologies.

Furthermore, training port security inspectors would be dramatically reduced, allowing for more inspections and lower overhead. At present, only wealthy nations can afford technology-based port inspection security methods; glass containers would benefit wealthy as well as poorer countries. This very fact may even allow ports to open up in countries that could not previously meet today's international security requirements. Ultimately, glass containers could result in the expansion of trade into those countries around the world most in need of trade and improve their economies.

Glass containers that are transparent to the naked eye would allow for security, customs, and police officers to thoroughly examine containers' contents. Suspicious cargo, contraband, dangerous materials such as drugs, hazardous or controlled chemicals, biological agents, and even human cargo, would be

easily identified using cameras that could examine all six sides of the containers. Officers would be able to quickly flag suspicious containers and open only those that present a threat. The search and security process would therefore be much more streamlined and efficient.

Additionally, these glass containers will directly enhance the ability of cutting-edge technology that is currently being developed for the identification of dangerous materials. Various probing techniques such as visible and infrared spectroscopy, and the potential for terahertz radiation spectroscopy to identify chemical species from a distance could be employed using transparent containers. The glass shipping containers would allow for faster, cheaper, and dramatically more accurate probing of shipping containers over any method that could be employed while still using metal as a container material.

Industry Benefits

The shipping industry would directly benefit from the use of 50X glass in shipping containers. Improved security checks could alleviate the current shipping industry bottleneck, an industry already struggling to cope with a 10% yearly increase in imports. To alleviate the ever-growing bottleneck, the industry has been focusing on the use of RFID (Radio Frequency Identification) tags on shipped goods. RFID tags act as radio transmitting bar codes, so that the contents of a package or of a pallet can be read from a distance. This dramatically impacts the shipping industry because shippers and freight consolidators can more quickly and more accurately track all of their cargo. However, this is only possible if the RFID system has high reliability and can be implemented within ports and on ships without an enormous number of transmitters and receivers. While metal containers can shield the RFID tags and keep them from functioning, glass containers would permit the unconstrained full function of these tags over long distances, allowing for high reliability and the use of relatively few transmitters and responders in the ports and on ships. Therefore, the business advantages of this RFID technology can be fully realized through the use of glass shipping containers.

In addition to the shipping industry benefiting from these new glass containers, the glass industry will experience a tremendous boost from this application of 50X glass. The market size of the glass industry is greater than \$1.5 billion dollars annually, and the technology should be easily defendable using patents or trade secrets or both. The enormous international security benefits of using glass containers in shipping could result in international governments mandating the use of these glass containers for security reasons and their demand would increase.

Environmental Sustainability Benefits

The construction of shipping containers out of 50X glass would help provide environmentally sustainable solutions to an industry plagued by major environmental concerns. As the industry grows by more than 10% in volume each year, millions of steel shipping containers are built with little to no opportunity for reuse and recycling. The current steel containers cost about \$2500 USD to make. They are predominantly made in China, and because of the trade imbalance with the North America and Europe, many hundreds of thousands of containers only travel one way because it is cheaper to make them than to ship them. This is a tremendous problem and there are few efforts to find alternative uses for these containers that have been abandoned.

In contrast, glass could be recycled or reused in an almost unlimited number of ways. Glass does not corrode or rust, and so while shipping containers require care due to the harsh conditions and exposure to salt air while in transit, the glass containers would not require paint or other protection from the salt air. Glass is a highly recyclable material, and unlike steel that may corrode or be treated with paint and anti-fouling agents, glass containers would be more easily ready for recycling as the walls themselves would be untreated with other materials.

Finally, the fundamental material base for glass is silicon in the form of silicate, the most common material in the earth's crust, therefore making it an ideal material for any large scale fabrication because it is the closest material to being unlimited on earth. So, as many resources on our earth become limited, the ability to produce something from these basic, unlimited materials is ideal from an economical, scientific, and manufacturing standpoint.

Feasibility

We must evaluate whether it will be possible to make containers out of glass, even if it is 50X stronger than traditional glass. Assuming that the glass fracture strength of the strong glass is 500,000 psi, this represents strength far greater than the tensile strength of typical steel with tensile strength ranging between 50,000-80,000 psi. In fact, the strength of this 50X glass is even greater than high quality steels with strengths up to 200,000 psi. With current dimensions and weights, the average thickness of a shipping container is about 3.5 mm, or 30 kg/m². Using the 50X glass, the containers could be made several times thinner than current containers, or the thickness can be maintained so that they could support several times their own weight using proper engineering and design. There may be new minor engineering challenges, but with this type of rigid strength there should not be problems producing large sheets of the strong glass that can be handled in the manufacturing process in a similar way to the current metal process.

Conclusions

To summarize the main points of this proposal, the 50X strength glass shipping containers will:

- Solve a major worldwide security concern by allowing for the inexpensive screening of all container-vessel cargo.
- Ease the use of technologies such as RFID tagging, which has the capability to dramatically improve efficiency and lower cost in the shipping industry.
- Address the environmental sustainability of the container manufacturing business by producing an easier container-recycling process, using an abundant material, and providing alternate uses for discarded containers.
- Provide a tremendous business opportunity for the glass industry worth billions of dollars in annual revenue.

Figure 1: Rendition of steel shipping container and 50X strength glass container

