# Low Temperature Metal Coating Method

**Project Accomplishments Summary**
**CRADA No. TSB-1155-95**

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## A. Parties

The project is a relationship between the Lawrence Livermore National Laboratory (LLNL) and Innovative Technology, Inc.

University of California
Lawrence Livermore National Laboratory
7000 East Avenue, L-795
Livermore, CA 94550

Innovative Technology, Inc. d/b/a Inovati
PO Box 60007
Santa Barbara, CA 93160

## B. Background

A new metal coating method, called KEM (kinetic energy metallization), demonstrated in the laboratory by Inovati, utilized fast-moving solid particles entrained in a gas that are caused to flow through a nozzle to effect particle deposition on metal surfaces at room temperature conditions. This method (US Patent 5,795,626) was an attractive and viable alternative to the currently available high-temperature coating methods available.

Since it differs significantly from existing metal coating technologies, a brief description of the method is included here. The proposed method, KEM, achieves cohesive and adhesive metallurgical bonding through the high-speed collision of powder with a substrate and the subsequent discharge of electrical charge at the substrate. Such coating is effected by entraining metal powder in a gas and accelerating this mixture through a supersonic nozzle. The gas/powder is directed towards the substrate to be coated. Collisions occur, initially between the powder and the substrate, and, as the first layer of the coating forms, between the powder and the coating. During these collisions the powder is rapidly deformed, causing the exposure of fresh (oxide free) active metal surface. When these active surfaces contact one another, they agglomerate and form true metallurgical bonds. The resultant coating has low porosity and high adhesive and cohesive strength. The formation of metallurgical bonds is potentiated by the discharge of electrical energy. This electrical energy is the result of triboelectric charging of the particles during acceleration and transit to the nozzle.

An advantage of the method is that it does not raise the temperature of the powder being applied or that of the substrate. Consequently, materials sensitive to high temperature may be applied without changing the properties of the material or substrate.

**Reasons for Cooperation:**

- LLNL Need: The Weaponization Program was interested in the method, especially as an inexpensive and efficient way of depositing Uranium for nuclear weapon refurbishment.

- Inovati Expertise / Need: Inovati demonstrated that metal deposition could indeed take place through the method. However, Inovati lacked analytical capabilities to address the fundamental physics of KEM.

- LLNL Expertise: LLNL possessed expertise in theoretically addressing the two-phase flow dynamics and the interaction phenomena between the impacting particles and the target material.

## C. Description

The purpose of the program for LLNL was to gain an understanding of the physical factors involved when high-velocity metal particles impinge on a metal surface. Insight thus obtained would aid in optimizing the metal-deposition operating conditions.

For the industrial partner, the purpose was to experimentally demonstrate the relevance and applicability of the method to the LLNL Weaponization Program, especially U-deposition for nuclear weapon refurbishment.

## D. Expected Economic Impact

The LLNL theoretical analyses of the underlying physics involved in metal deposition with gas / solid nozzle flows would enable Inovati to optimize the operating conditions, and allow for the low-cost development of the KEM product. The work would have a major impact on the time required to move this technology from the laboratory to the marketplace.

When introduced to the marketplace, KEM will provide a lower cost (both acquisition and life cycle cost) alternative to conventional coating processes. Subsequent to this work KEM has proved to be a viable alternative to certain laser assisted deposition, thermal spray, vapor deposition, and chemical and electrochemical platting processes. KEM is under evaluation to replace these processes because it is cheaper and produces none of the environmental hazards associated with them.

KEM is expected to help maintain the U.S. leadership in metal coating technology. This leadership role has resided in the United States for over 50 years though new developments are increasingly originating in Europe and Japan.

## E. Benefits to DOE

**Laboratory Program core competencies:** The theoretical analyses (LLNL) and tests (Inovati) had direct impact on U-deposition for nuclear weapon refurbishment project currently under way at LLNL as a part of the LLNL Weaponization Program. The cognizant personnel at LLNL expressed specific interest in this proposal as a very viable alternative to some traditional metal deposition technologies that were becoming increasingly unattractive due to high cost and environmental constraints.

Another way in which the proposed method enhanced the LLNL weapons core competencies was its application for the long-term storage strategies of radioactive weapons components that call for encapsulation with metal.

**DOE/Defense Programs:** The method has wide applicability to the Defense Program Missions and Critical Technologies, notably material welding and fabrication connected to the material science and technology, national ignition facility, factory of future and systems engineering and manufacturing technologies.

## F. Industry Area

The transportation and electronics industries are the focus of KEM commercialization efforts. Products for these industries are now under development with the help of two DOD and one DOE sponsored research projects. Private industry is providing matching funds in support of this research. Through this work commercialization is expected within two years.

Inovati has installed a KEM system in the Thermal Spray Laboratory at the State University of New York, Stony Brook, where additional research and characterization of the system is taking place.

## G. Project Status

This was a four-month CRADA. It was completed in October 1996.

Sang-Wook Kang, L-140
Tel: (510) 422-7233
Fax: (510) 422-5397
email: kang1@llnl.gov

## I. Company Size and Point(s) of Contact

Inovati annual sales are less than $5 million, and the company employs less than 20 people.

Howard Gabel
President
Tel: (805) 571-8384
Fax: (805) 571-6200
email: hgabel@inovati.com
www: http://www.inovati.com

## J. Project Examples

None

## K. Intellectual Property

Subject Inventions:
CRADA Article I defines a Subject Invention as any invention of LLNL or Participant conceived or first actually reduced to practice in the performance of work under this CRADA. CRADA Article XIII requires each Party to disclose to the other every Subject Invention, and provides that the inventing Party has first option to retain title to any Subject Invention made by its employees during work under this CRADA.

LLNL Subject Inventions: None
Participant Subject Inventions: None

Copyright:
CRADA Article X provides that each party may assert copyright in its Generated Information, including computer software and documentation produced under this CRADA.

LLNL computer software / documentation: None
Participant computer software / documentation: None

## L. Release of Information

**I certify that all information contained in this report is accurate and releasable to the best of my knowledge.**

Karena McKinley, Director
Industrial Partnerships
and Commercialization

Date

**RELEASE OF INFORMATION**

I have reviewed the attached Project Accomplishment Summary prepared by Lawrence Livermore National Laboratory and agree that the information about our CRADA may be released for external distribution.

Howard Gabel, President
Innovative Technology, Inc.

Date