CRYSTAL LTD.

NEW PRODUCTION TECHNOLOGIES OF THERMOELECTRIC MATERIALS AND MODULES

Crystal Ltd. was established in 1990 by a group of engineers of the Moscow Steel and Alloys Institute to realize the results of R&D works and their own original ideas in the filed of thermoelectric materials crystallization. Since the very day of its establishment Crystal Ltd. is aimed at **development and realization of its own original technologies in practical thermoelectricity**, namely production of the bulk thermoelectric materials based on Bismuth Telluride solid solutions and thermoelectric modules assembled from such materials.

This strategy helped Crystal Ltd. to become one of the world leaders in supplies of thermoelectric elements (TE) and thermoelectric modules (TM) with high efficiency and reliability.

The base of thermoelectric elements production technology of Crystal Ltd. is a unique patented technology of thermoelectric material growing in shape of profiled crystals and plates using modified Bridgman's method.

These objects are being crystallized from a liquid melt due to temperature gradient in flat cavities made in the graphite tooling fixture. Such conditions of crystallization ensure strict orientation of material's crystalline structure and optimal combination of high thermoelectric and mechanical properties.

This method has an undoubted advantage (in terms of economics as well): the plate thickness or profiled crystal cross-section (EQUAL to cross-section of elements used for assembling of module) are defined at the very stage of crystallization process, i.e. two (2) or four (4) surfaces of the element from six (6) are formed by crystallization process and not by cutting. Thickness (cross-section) of profiled plate (or crystal) can vary from 0.3 to 5.0 mm. To form finally the Thermoelectric element for assembling into module, we use our own original **"CLEAN" technologies** to cut plates (crystals) and apply antidiffusion coating that ensures high operation parameters both of Thermoelement and module including long lifetime and high thermal stability within temperature range up to 150^0C. Particularly we use a method of electro-erosive cutting by a thin wire (30 microns) in a specially prepared "clean" deionized water, as well as electron-beam evaporation, magnetron and resistive methods of the **multilayered coating application in vacuum**. Therefore the thermoelectric parameters of our TE and TM even grow during operation!

As a special note it is necessary to point that at the first stages Crystal Ltd has mastered the traditional methods (Fig. 1) of thermoelectric modules fabrication, but now Crystal Ltd. realizes **its own conception of modules assembling process** based of advantages, gained experience and further development of its original technology of thermoelectric material crystallization.

For more information please contact us:

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The method of thermoelectric elements production for assembling into modules by a standard (traditional) technology

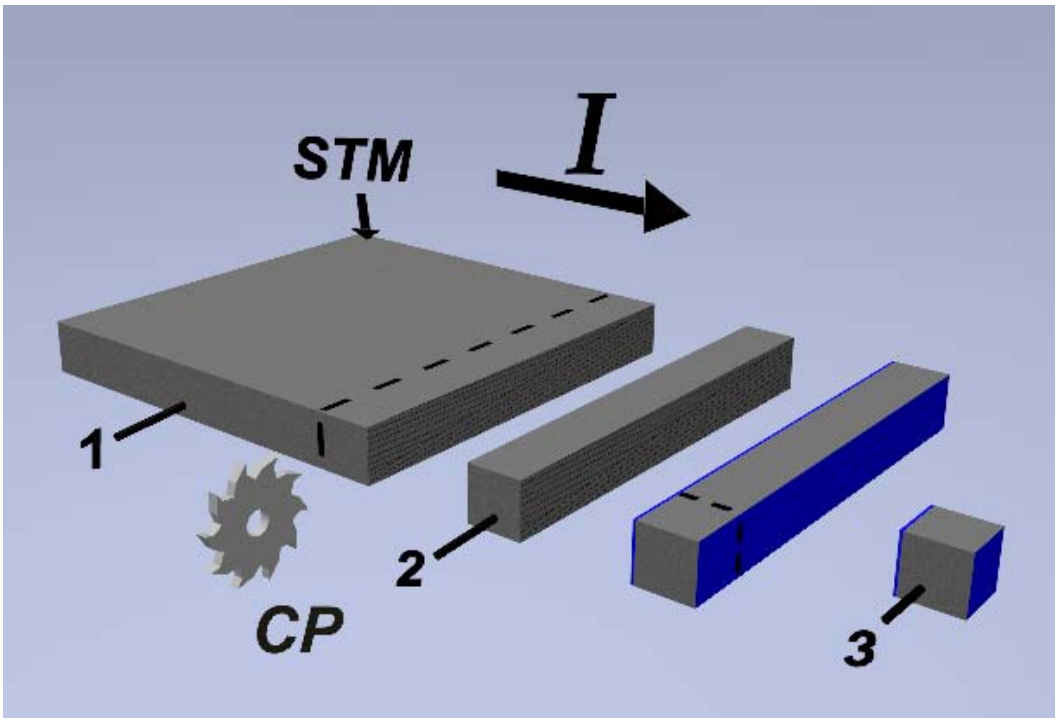

Fig. 1.

STM: Semiconductor thermoelectric material
I: Direction of current
CP: Cutting plane

1: Plate of thermoelectric material (P- or N-type)
2: Profiled crystal (P- or N- type)
3: Thermoelectric element (P- or N- type)

A short Illustration of two patented production methods of thermoelectric modules from “glued” profiled plates (Fig. 2-4) as well as from profiled crystals (Fig. 5, 6) of different (P&N) conductivity types is given below.

Method of thermoelectric modules production from “glued” profiled plates

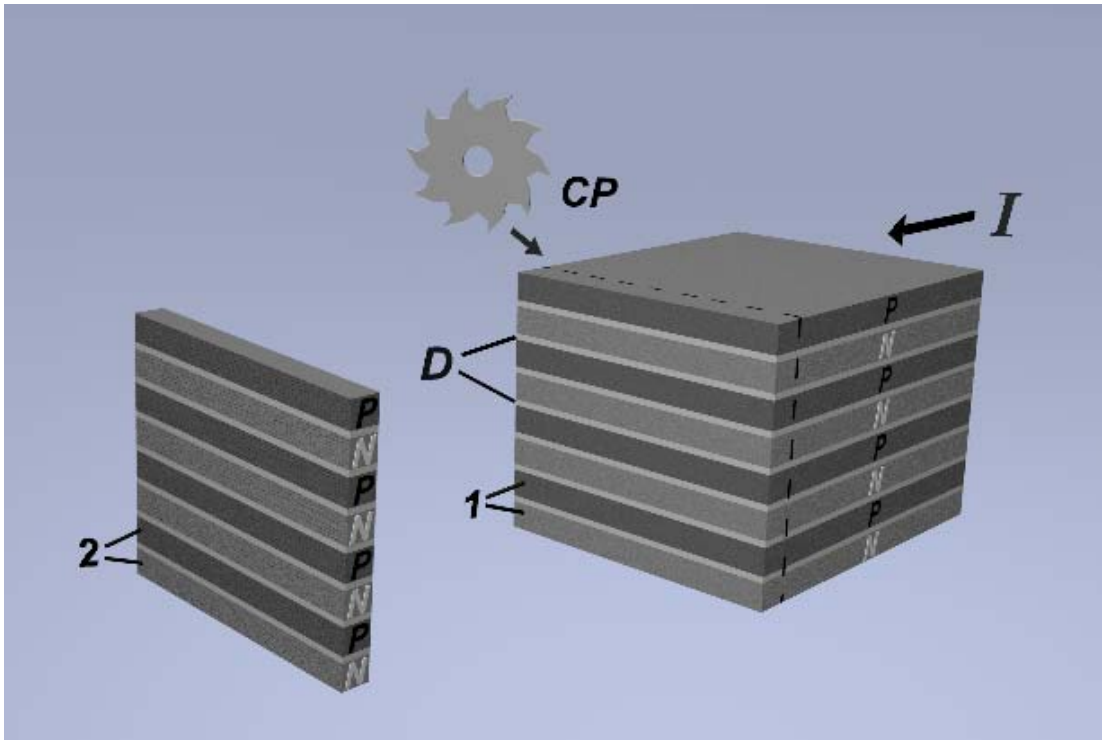

Fig. 2.

I: Direction of current
CP: Cutting plane
D: Dielectric layer (insulator)

1: Plate of thermoelectric material (P- and N-type)
2: Profiled crystal (P- and N- type)

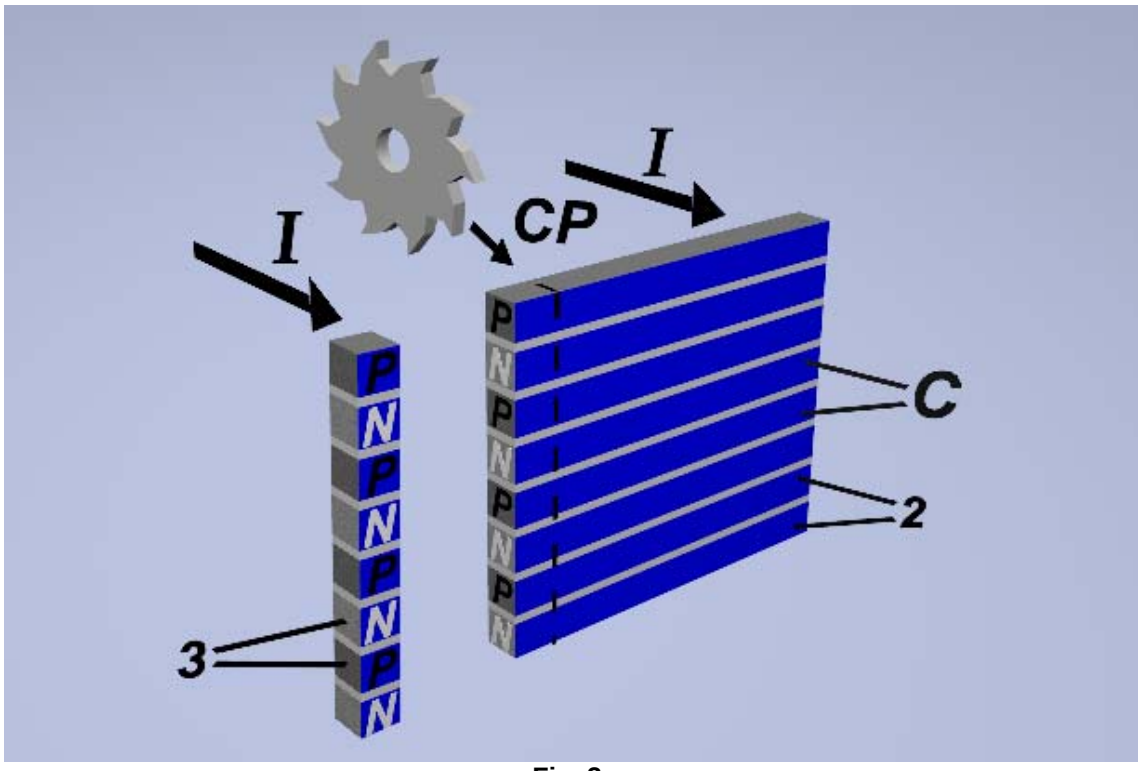

Fig. 3.

I: Direction of current
CP: Cutting plane
D: Dielectric layer (insulator)
C: Complex multilayered coating
2: Profiled crystal (P- and N- type)
3: Thermoelectric elements (P- and N-type)

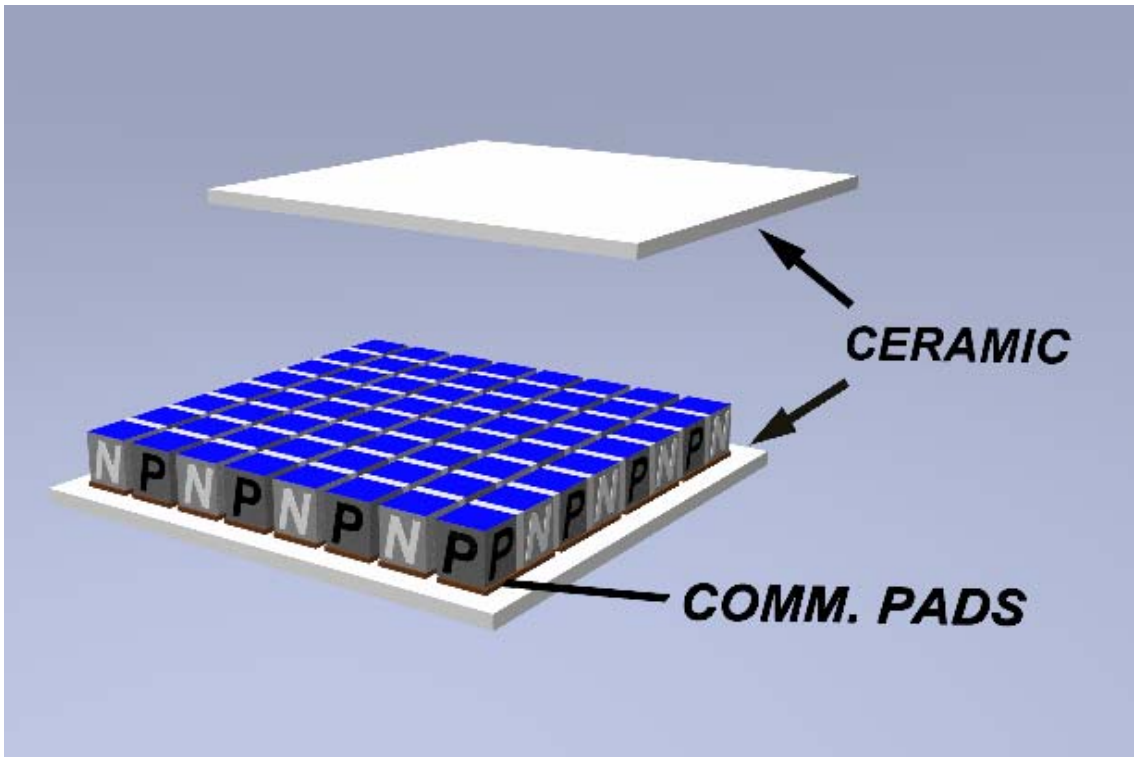

Fig. 4.

Method of thermoelectric modules production from profiled crystals

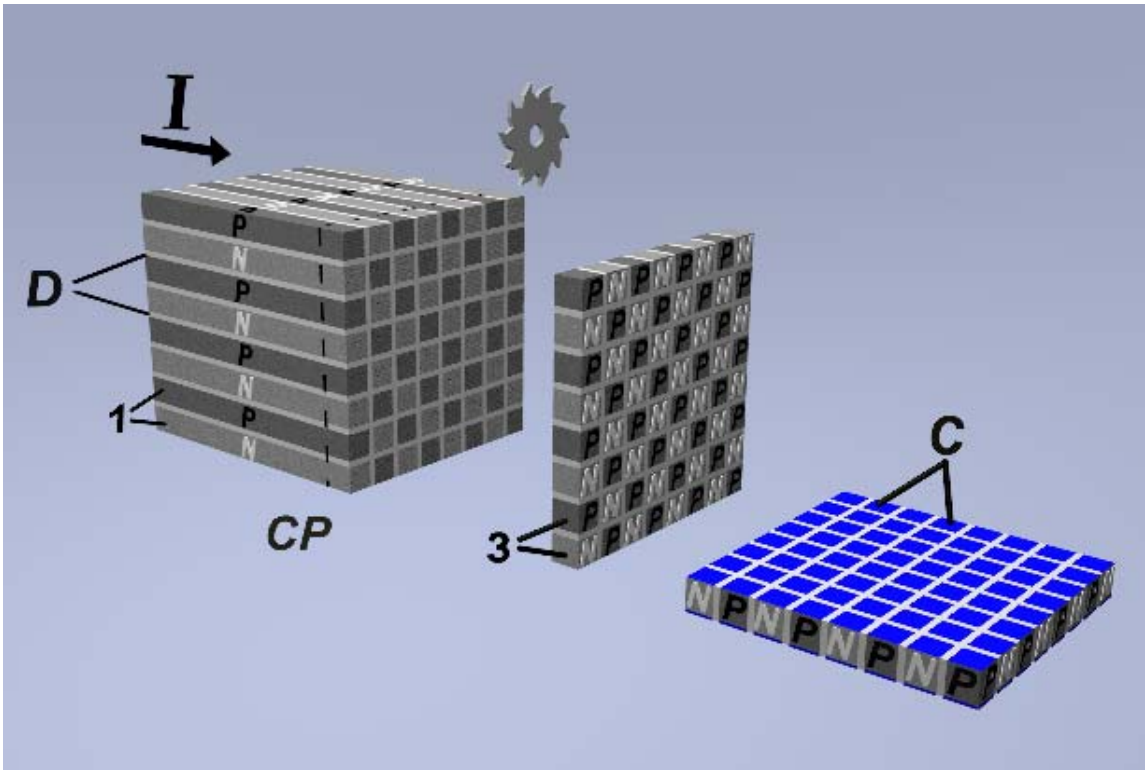

Fig. 5.

I:	Direction of current	1:	Profiled crystal of thermoelectric material (P- and N-type)
CP:	Cutting plane	3:	Thermoelectric elements (P- and N- type)
D:	Dielectric layer (insulator)		
C:	Complex multilayered coating		

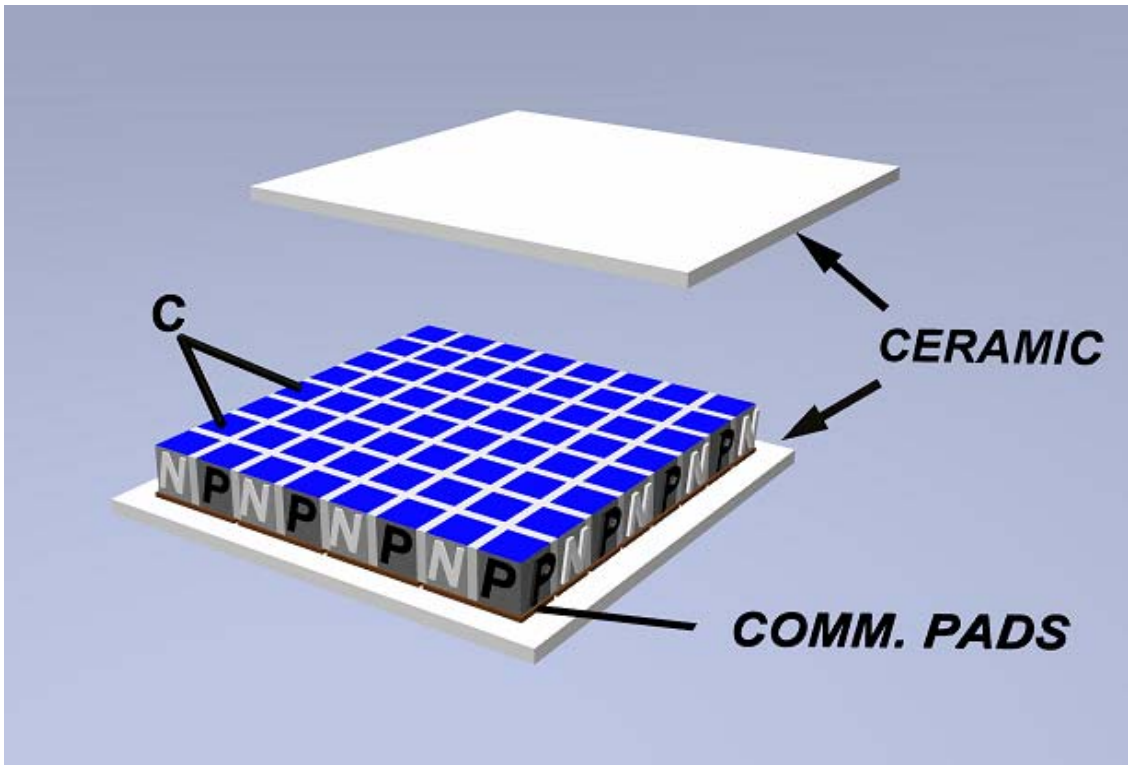

Fig. 6.

These developments are made with support from Russian Agency on Science and Education with participation of Russian educational and academic institutes. Crystal Ltd. invites all foreign companies, interested in further development of these new technologies, to cooperate as a Partner or Co-Executor.

To the future of thermoelectricity – together with Crystal Ltd.!