



# ***Electron-beam sintering of metalloceramic materials in medium vacuum***

**Aleksandr Klimov,  
Ilya Bakeev,  
Efim Oks,  
Aleksy Zenin**

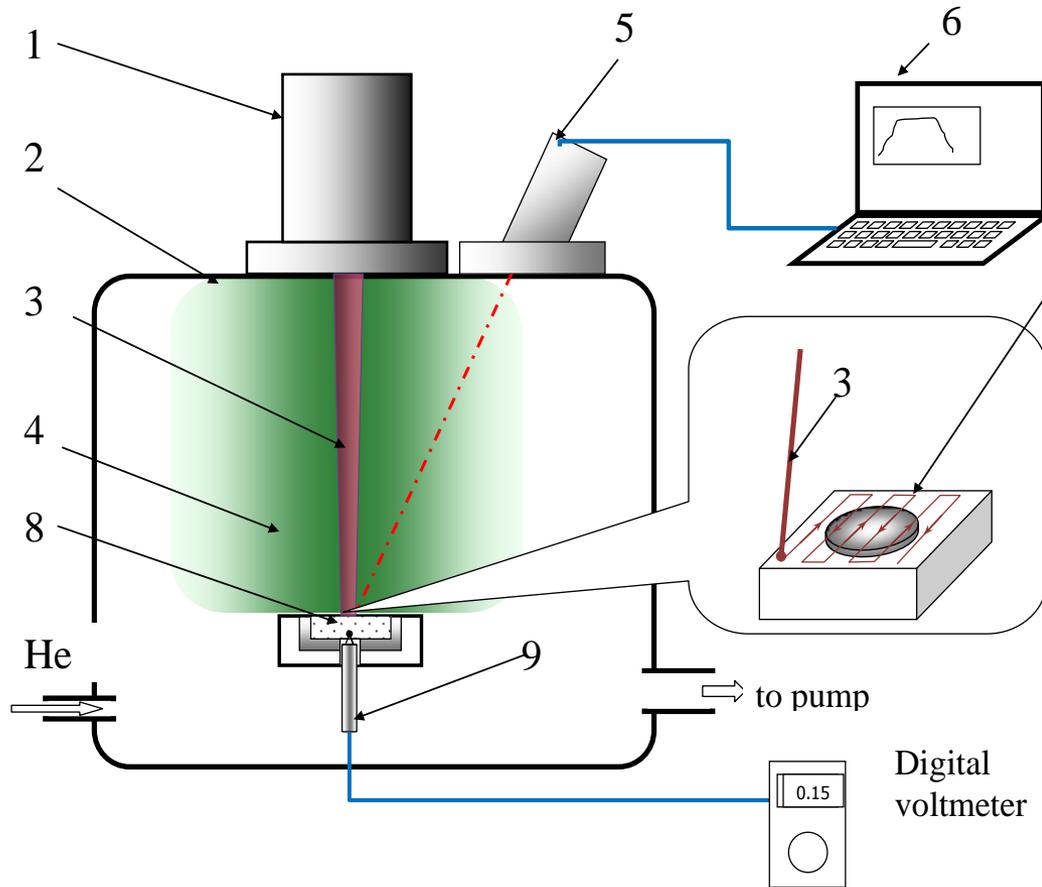
**Tomsk, 2020**

# Abstract

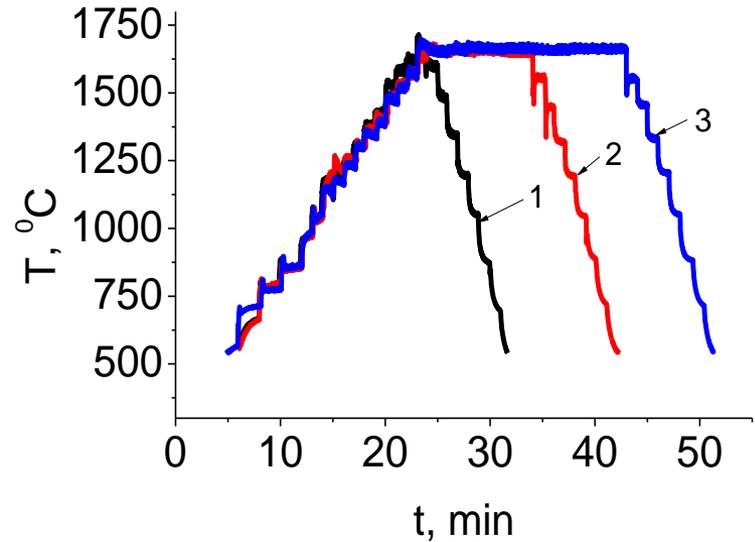
Ceramic-metal composite materials are promising materials of modern high-tech production. They combine a number of unique properties inherent in both ceramics (hardness, high strength, low creep) and metal (high thermal conductivity, electrical conductivity, resistance to shock loads). The current stage of technology development requires both improving methods for creating such materials and searching for new methods for their production.

In the present work, the results of electron beam sintering of a ceramic-metal compact by a focused beam in the medium vacuum pressure range are presented. It is shown that by heating the compacts it is possible to achieve a uniform distribution of elements over the volume of the sintered sample.

# Schematic of the experimental setup and parameters



1 - plasma electron source, 2 - vacuum chamber, 3 - electron beam, 4 - electron-beam plasma, 5 - infrared pyrometer, 6 - computer, 7 - electron beam scanning scheme, 8 - sintered compact, 9 - thermocouple.

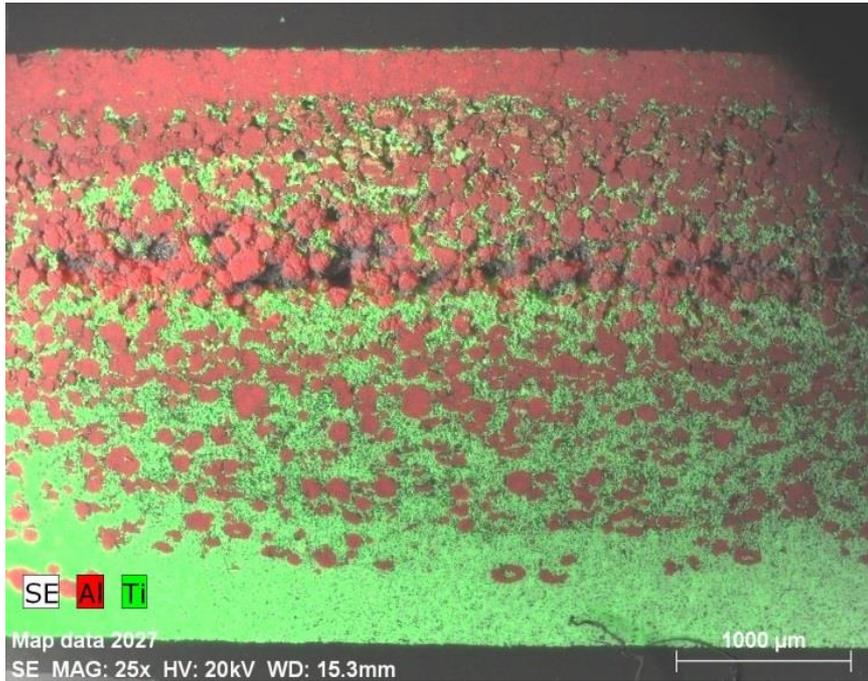


The dependence of the surface temperature of the samples in the sintering process. The isothermal exposure time is 1-1 minutes, 2-10 minutes, 3-20 minutes.

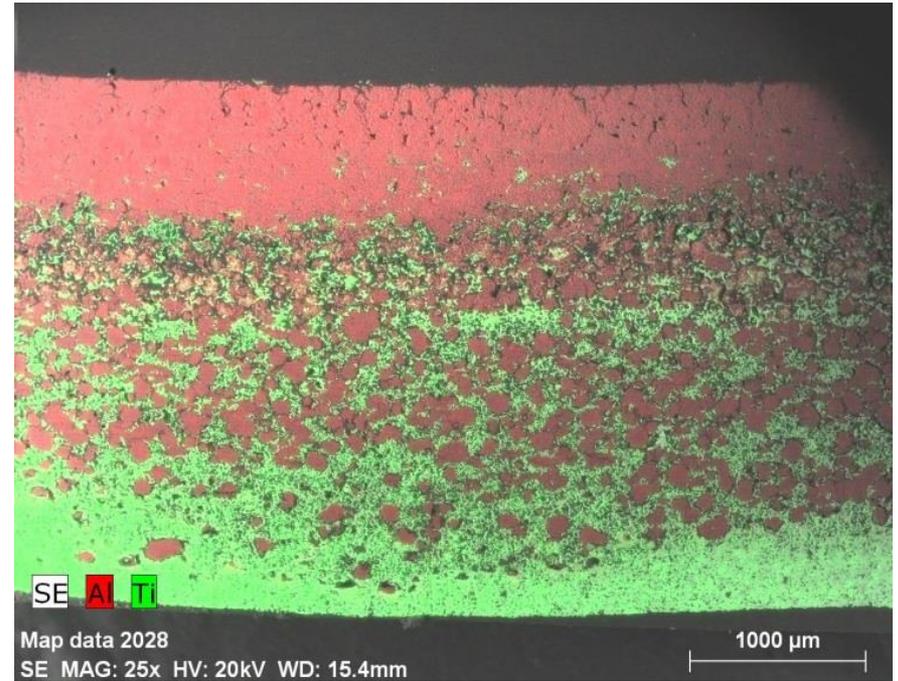
# Sample parameters before and after sintering

Heating time	1 minutes		5 minutes		10 minutes		20 minutes	
	Before	After	Before	After	Before	After	Before	After
Mass, mg	445	428	497	485	499	480	463	424
Volume, mm <sup>3</sup>	227	214	251	216	245	215	233	189
Density, g/cm <sup>3</sup>	1,96	2,00	1,98	2,24	2,04	2,23	1,98	2,27

# Micrograph of a cross section



Sample 1



Sample 4

Reducing the time of electron-beam irradiation on a compact leads to an increase in its porosity

# Conclusion

Electron beam irradiation of ceramic compacts in the fore-vacuum pressure range allows sintered samples to be obtained in 45 minutes. The density of the samples in this case reaches  $2.27 \text{ g / cm}^3$ . The sintering uniformity is influenced by the isothermal holding time, the minimum holding time to obtain a sintered sample is 10 minutes. Further research should be aimed at finding ways to reduce the temperature difference in the thickness of sintered compacts.

The work was supported by the Grant of the President of the Russian Federation  
(№.MD-2649.2019.8)