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MICROWAVE PROCESSING OF MATERIALS: LATEST ACTIVITIES AT PENN STATE MICROWAVE CENTER

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Microwave technology is being applied in materials processing for synthesis, sintering, melting, joining, surface-modifications, etc. Microwave processing is recognized for many advantages namely energy-efficiency, cost-effectiveness, reduction in cycle time, providing fine microstructures leading to improved mechanical properties and overall performance of the product.

Penn State microwave center has been pioneer research facility in many materials processing areas such as WC/Co based cemented carbides and metallic materials. We have been conducting research in microwaves processing for more than two decades, and worked with variety of materials. In 1980s our activities were mainly confined to oxide ceramics, hydroxyapatites and transparent ceramics. In 1990s we moved on to non-oxide ceramics including WC/Co based cutting tools, diamond composites and synthesis and sintering of important electroceramics. In all these materials we were quite successful in obtaining products with substantial improvements in their properties over conventional product as well as enhancements in the diffusion and reaction kinetics. Then towards late 1990s, it was discovered that metals can also be processed in microwaves very effectively. It is generally known that metals reflect microwaves, however, what was found that if the metals are in powder form, they will absorb microwaves and get heated very effectively leading to their sintering and even melting. Almost all metals, including refractory metals (W, Re, Mo,), alloys, steels, and intermetallics were sintered successfully in 5-15 minutes.

Thus far until 2000 most researchers working in microwave field had been using only multi-mode microwave systems. However, the science behind microwave-matter interaction based on the results obtained in multimode cavity could not be satisfactorily explained. Recently, we conducted an extensive investigation of the effect of E and H field separation in a single mode cavity on the heating profiles of many materials, and found many surprising results including de-crystallization of many materials. This presentation will summarize these and other important developments in the field.