Changing Views on 6G: Metamaterials and RIS - New Market Research Report on 6G Communications

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6G wireless communication coming in around 2030 needs widely-deployed Reconfigurable Intelligent Surfaces RIS. Some years will see over 200 million square meters deployed, RIS hardware sales rising to over $12 billion yearly, related costs such as installation greatly adding to this. The new Zhar Research report, "6G Communications: Reconfigurable Intelligent Surface Materials and Hardware Markets: SubTHz, THz, Optical 2024-2044" gives the latest situation and prospects ahead. Uniquely focussing on clearly identifying the materials and hardware needed, free of the obscure software analysis and mathematics of other reports. It is based on close analysis of what is needed, what will possible, the research pipeline – much boosted in 2023 – and how the participants are repositioning. Reports not analysing these major changes from 2023 are relatively useless.

Dr Peter Harrop, CEO of Zhar Research says,

> “We find that, without RIS, there will be no 6G. These metasurfaces empowering the propagation path and enhancing base stations will be key both to affordable 6G deployment and to delivering its essential business cases. 6G RIS will appear in many different forms and at many frequencies, from 0.1THz to 1THz and even potentially visible light in later years. Some RIS will even be transparent to retrofit on windows. However, 2023 saw radical changes in achievements and objectives. Uniquely this commercially-oriented report covers that, including many new RIS security issues and particularly presenting our latest analysis of materials and hardware opportunities, including gaps in the emerging market from 2024-2044.”

The report advises that, like 5G, 6G will start at the bottom of an envisaged band – around 0.1-0.3THz - to get huge performance increase – then add higher frequency versions for stellar performance when the massive challenges analysed in this report are overcome, maybe a Phase 2 in 2035. That may involve adding 0.3-1THz capability, active (powered) RIS that operates unpowered client devices, near infrared and visible light RIS and other advances forecasted.

Within that, expect major demand for the value-added materials involved including graphene, 3-5 compounds, vanadium dioxide, sapphires and certain organics that are detailed and fine patterning, transparency, chip arrays and other requirements make the market attractive, avoiding commoditisation. Vast areas od regular polymer films as substrates are another aspect.

The Executive Summary and Conclusions has 35 information-packed pages, mostly 16 key conclusions, new infograms, tables, graphs and SWOT RIS appraisal. There is a detailed roadmap and 21 forecast lines 2024-2044.

The 99-page Introduction then gives unusually comprehensive coverage of the basics as seen in the very different light of 2023 onwards with a profusion of references for further reading. It includes basic RIS design and purpose, derisking investment for multiple applications, for this report is commercially oriented. See infograms of intended 6G and its RIS across land, sea and air plus what companies are likely to participate where. Understand the unsolved 6G rural challenge and difficulty providing extra infrastructure and many functions. Here you navigate the confusions of RIS terminology, metamaterials and metasurfaces involved, six operational and three directional modes. Such RIS and 6G are compared to traditional approaches and the need for better focus in objectives and standards becoming urgent, since RIS hardware lags progress in 6G system design. Because this is analysis not evangelism, there is a very close look at the pros and cons of frequency choices and RIS becoming part of the problem of this industry grabbing too much of the world’s electricity supply, creating heat.

The 32 pages of Chapter 3 are on “Metamaterials and manufacturing technologies for 6G and major advances and changed views from 2023”. Understand the meta-atom pattern behaves like an atom, the patterning commercial, operational, theoretical, structural and manufacturing options. Six formats metamaterial are here with materials examples leading to metasurfaces, hypersurfaces and the long-term picture of metamaterials overall, even metasurface energy harvesting likely for 6G then applications of GHz, THz, infrared and optical metamaterials. There is a SWOT assessment. However, vitally, half the chapter reveals major changes in 6G perceptions, plans and progress from 2023 starting with 15 examples analysed. New infograms and a SWOT make it easy to grasp.

Chapter 4 runs to a full 99 pages in order to drill down into detailed materials and device aspects of the

different RIS designs needed for different frequency bands and so on. See appraisal of 9 tuning device families for RIS from the recent research pipeline and where the research will be headed in future. There is detail on beam forming, many operating principles affecting materials choices, the merits of semi-passive. Understand active RIS components including such things as High Electron Mobility Transistors HEMT, hybrid CMOS, phase change materials such as vanadium dioxide and chalcogenides and trials of graphene plasmonics in RIS. Learn more on coping with the terahertz gap and on making transparent RIS. Throughout, the latest advances from 2023 are particularly explored.

Chapter 5 (37 pages) concerns issues, opportunities and gaps in the market as we urgently progress from small scale demonstrations to proving and installing the necessarily large RIS across the landscape. Called, “6G THz reconfigurable intelligent surfaces in action: materials, hardware, location and installation issues” it covers 6G underwater, underground, for agriculture, smart factories including their transmissive windows and Industry-6.0. Learn RIS smart radio environments and the issues of selection of sites, components, materials. Be surprised by the cost breakdown of a typically planned RIS. Just how realistic is the dream of RIS Simultaneous Wireless Information and Power Transfer SWIPT enable unpowered, battery-less edge devices at later stage? Many new infograms make all this both clear and comprehensive. Then come comparison tables of opportunities with organic, inorganic and high added value constructs. The chapter ends with the many RIS security concerns coming center stage from 2023 onwards.

Chapter 6 is brief but important. Called, “6G optical reconfigurable intelligent surfaces: near IR and visible” its 20 pages show how the essential role of these frequencies in 5G and 6G in the form of fiber optics is only the beginning. Near IR and visible light can have a place in free space optical transmission and specifically indoor and outdoor LiFi to improve reach and performance. Learn how there is even promising work on handling THz and these frequencies in a single RIS. On the other hand there are optical devices potentially enhancing or replacing RIS.

The report ends with a 75-page chapter on RIS-related companies, collaborations and national and regional initiatives across the world. . The new Zhar Research report, "6G Communications: Reconfigurable Intelligent Surface Materials and Hardware Markets: SubTHz, THz, Optical 2024-2044" is essential reading for those seeking to supply the added-value materials and components required. It also has much to interest investors, operations, system integrators and others in the emerging 6G value chain.

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